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NETWORK INTERACTION - DEVELOPMENT OF EXPERTISE IN FINNISH TECHNICAL CONSULTANCY FIRMS

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Kansallinen kilpailukyky ja teollinen tulevaisuus -projektissa tutkitaan, millaista teollista toimintaa voidaan harjoittaa Suomessa menestyksekkäimmin. Siinä tutkitaan menestyneitä vientiyrityksiämme ja pohditaan, miten niiden toimintaympäristöä tulisi kehittää, jotta ne pystyisivät saavuttamaan kilpailuetuja kansainvälisiin kilpailijoihin verrattuna.

Projektin päärahoittajina ovat Suomen itsenäisyyden juhlarahasto (SITRA), Elinkeinoelämän Tutkimuslaitos (ETLA), kauppa- ja teollisuusministeriö (KTM) sekä eri alojen tärkeimmät yritykset.

"The Competitive Advantage of Finland" research project evaluates the competitiveness of Finnish export industries and crucial elements behind their performance. The project focuses on what kind of industrial activities have we best possibilities to be successful in Finland.

The project is organised by Etlatieto Ltd and financed mainly by the Finnish national Fund for Research and Development (SITRA), The Research Institute of the Finnish Economy (ETLA), Ministry of Trade and Industry (KTM) as well as major companies in various fields.

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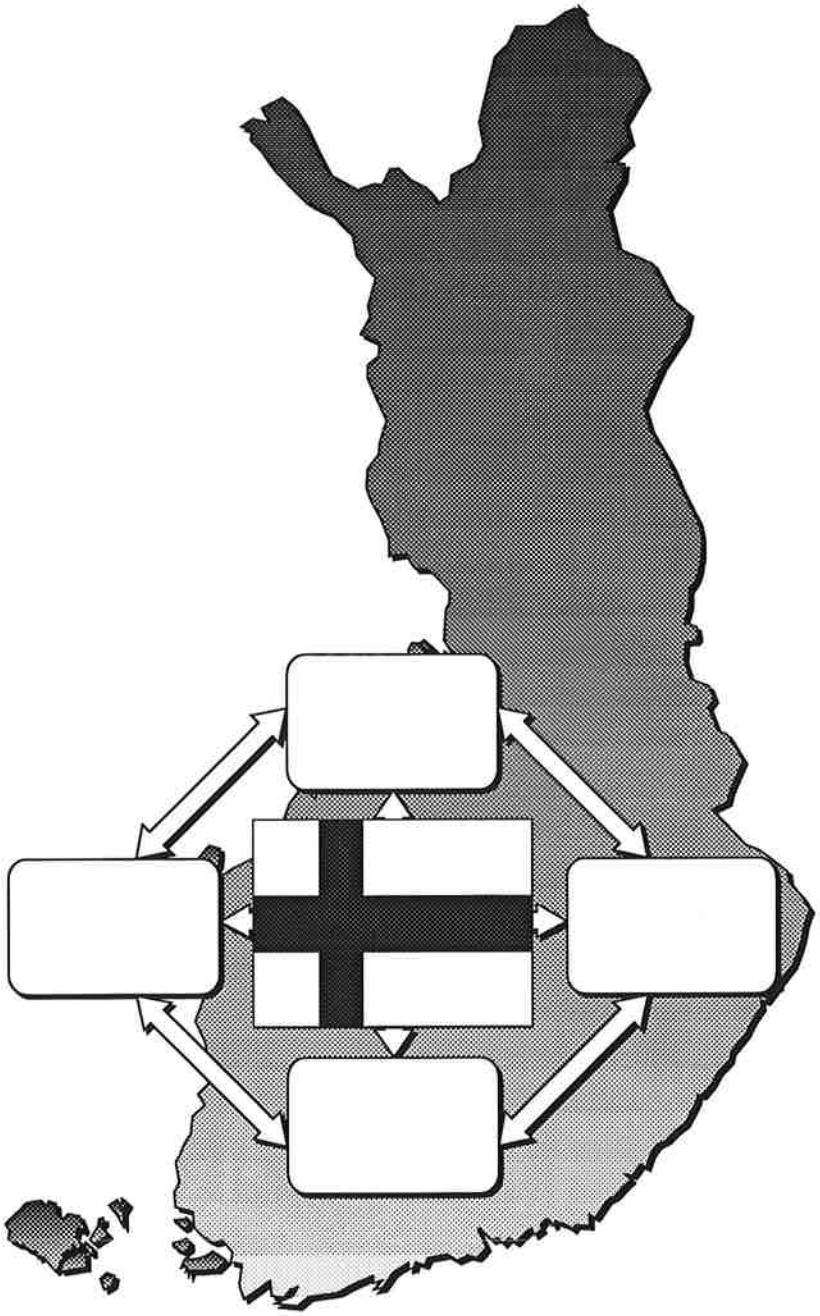
Kansallinen kilpailukyky ja teollinen tulevaisuus

The Competitive Advantage of Finland

NETWORK INTERACTION - DEVELOPMENT OF EXPERTISE IN FINNISH TECHNICAL CONSULTANCY FIRMS



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TIIVISTELMÄ: Keskusteluaihe 445 on osa Etlatieto Oy:n koordinoimaa Kansallinen kilpailukyky ja teollinen tulevaisuus -tutkimusprojektia. Tämän osatutkimuksen tavoitteena oli tutkia ja kuvata teknisten konsulttitoimistojen teknologisen tietotaidon ja asiantuntemuksen kehittymistä yritysverkostossa tapahtuvan vuorovaikutuksen tuloksena. Tutkimuksessa pyrittiin arvioimaan vuorovaikutuksen kokonaisvaikutusta kehitykseen ja verkoston eri jäsenten merkitystä kehitykselle, sekä selvittämään kehitysprosessin kulku ja mekanismit. Teknisten konsulttitoimistojen teknologisen tietotaidon ja asiantuntemuksen kehittyminen nähtiin teknisenä kehityksenä, joka perustuu vähittäisiin teknologisiin innovaatioihin.

Tutkimuksen tuloksista voidaan päätellä, että vuorovaikutus yritysverkoston jäsenten kanssa on tekniselle konsulttitoimistolle tärkeä ja luontainen väylä edesauttaa teknistä kehitystä. Kehitys perustuu vuorovaikutuksen kautta tapahtuvaan interaktiiviseen oppimisprosessiin sekä teknologian ja tiedon leviämiseen. Tärkeimmät verkoston jäsenet vuorovaikutuksen kautta tapahtuvan teknisen kehityksen kannalta ovat asiakkaat, laitetoimittajat ja tutkimusorganisaatiot.

AVAINSANAT: yritysverkosto, vuorovaikutus, innovaatio, tekninen kehitys, tekninen konsultointi

Palo, Katriina, **NETWORK INTERACTION - DEVELOPMENT OF EXPERTISE IN FINNISH TECHNICAL CONSULTANCY FIRMS**, Elinkeinoelämän Tutkimuslaitos, The Research Institute of the Finnish Economy, 1993, 46 s. (Keskusteluaiheita, Discussion papers, ISSN 0781-6847; no 445).

ABSTRACT: This discussion paper is published as a part of The Competitive Advantage of Finland research project which is organized by Etlatieto Ltd. Aim of the study was to evaluate and describe development of technological know-how and expertise of technical consultancy (TC) firms as a result of interaction in industrial networks. Objectives were set to evaluate the total impact of network interaction on the development as well as the varying importance of different network parties for the development, and to describe the process and mechanisms of the progress. Development of technological know-how and expertise in TC firms was seen as technical development based on incremental technological innovations.

Based on the study it can be concluded, that interaction with various network members is an essential and natural way for TC firm to foster its technical development. The development is based on interactive learning, and diffusion of technology and information, all enabled by interaction. The most important network parties in this process are customers, equipment manufacturers and research organizations.

KEY WORDS: network, interaction, innovation, technical development, technical consultancy

EXECUTIVE SUMMARY

The aim of the study is to evaluate and describe the effects of network interaction on development of technological know-how and expertise in technical consultancy (TC) firms. The process and mechanisms of the progress are explored.

The study consists of theoretical and empirical parts. Theoretical part provides the framework and concepts for evaluation of the phenomenon in focus. Theories related to industrial networks, interaction, innovations and industrial services are presented, and a model is developed to describe TC firm's technological development through network interaction. Selection of interaction and network approaches for the basis of the study is supported by the interactive nature of TC firm's operations.

The empirical part of the study consists of four cases describing the development of technological know-how and expertise in Finnish TC firms operating in energy sector and forest industries. The model developed in the theoretical part is applied to the case firms.

The results of case studies support the theoretical suggestions and view of interactive development process of technological expertise in TC firms. Technological development in TC firms can be seen as an outcome of interactive learning, and diffusion of technologies and information, all enabled by interaction between firms. Interaction enables common problem solving and thereby interactive learning, and provides a channel for diffusion and transfer of technologies and information.

The most important network parties in all cases contributing to interactive technological development are customers, equipment manufacturers and research organizations. Interaction is typically close and cooperative in the ongoing projects with customers and equipment manufacturers forming a productive basis for technical development. Interaction is also regular outside the projects with equipment manufacturers and research organizations.

The cases also show that the need for interaction to promote know-how and expertise varies according to TC firm's background and field of operations. In general, dependence on outside linkages to enhance technological development is reduced if strong internal organizational synergy, and own research and other resources are found. Well developed field of operations with many diversified actors creates opportunities for particularly efficient accumulation of know-how and expertise through interaction.

The selected four case firms, IVO International Ltd, Ekono Energy Ltd, CTS Ekono and Jaakko Pöyry Group, are the leading TC firms in the fields of thermal power and pulp and paper engineering in Finland. Their share of the rough estimate of the Finnish 1991 total TC exports FIM 1000 million is estimated to be around 40%.

For IVO International interaction with outside parties to enhance technological development is less important than for other case firms due to IVO's own vast research and other resources and organizational synergy. IVO International is also able to conduct more intense cooperation with outside research institutes as IVO's own research activities create an asset for mutual exchange of resources, where both parties derived benefit from interaction. Positive effects of network interaction in energy sector are to some extent reduced by the lack of advanced domestic manufacturers.

Competitive, strong and well developed domestic forest products industry has provided an excellent support for technological development through interaction for both CTS Ekono and Pöyry. They have benefitted from interaction with demanding and advanced domestic customers and equipment manufacturers, and with the numerous research organizations engaged in research in the field. CTS Ekono's relationships and interaction with actors in the industry have been particularly cooperative because of the company's ownership structure. Various joint-research programs organized in cooperation with all actors in forest products industry to enhance the overall know-how and expertise in the field were prominent. The synergistic link between energy sector and forest products industry has been efficiently exploited by Ekono Corporation.

IVO International Ltd, Ekono Energy Ltd and CTS Ekono have all benefitted to a varying extent from preferential interaction with their owners as customers. This can be positive when leading to particularly close and cooperative interaction, but it also can erode the case firms' expertise as the competition becomes biased.

Interactive development process of technological know-how and expertise in the four case firms is facilitated by two factors. Firstly, due to the smallness of the Finnish economy both the energy sector and forest products industry are small and number of actors limited, which makes the diffusion of information and technologies fast and efficient. Secondly, both thermal power production and pulp and paper production related technologies are considered conservative and conventional. Development process of technologies is gradual and slow, and therefore easy to follow. Conservativeness also reduces the importance of basic research lacking in most case firms.

Importance of wide network of manufacturers in the enhancement of technological development through interaction is emphasized by the fact that the case firms' expertise is based on various technological areas and they consequently need contacts to several manufacturers to keep in pace with technological development.

TC firms' technological development can ultimately be seen to depend to a great extent on external factors such as the level of basic research, equipment manufacturers' product development work and customers' needs. TC firms concentrate on innovatively adjusting themselves to the changing situations caused by technological development in the field, and on being able to develop a functioning system of available technologies suitable for customers' needs. Successful innovative adjustment to technological changes caused by external factors in enabled by effective interaction with research organizations, equipment suppliers and customers.

NETWORK INTERACTION - DEVELOPMENT OF EXPERTISE IN FINNISH TECHNICAL CONSULTANCY FIRMS

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1. INTRODUCTION

1.1. BACKGROUND

A large-scale research on the Finnish economy is being carried out by the Research Institute of the Finnish Economy (ETLA) in cooperation with the Helsinki School of Economics and Business Administration. Aim of the research project "Advantage Finland" is to find out what kind of future industrial structure Finland should have to successfully face the structural changes of the 1990s. The research may thus serve as a criterium for formulation of new industrial, economic and competition policies.

The research is largely based on the diamond model and cluster concept presented by Michael Porter in his work "The Competitive Advantage of Nations" (1990). Porter suggests, that nation's industrial environment and competitive clusters of firms, and their contribution to innovations and upgrading are essential in striving for national competitive advantage. The focus of the research project will be on competitive industrial clusters in Finland. Competitiveness, success factors and future perspectives of clusters will be explored.

The present study of technical consultancy (TC) firms is included in the project because of the firms' suggested role as related and supporting industry in clusters. Based on the diamond model it is assumed, that the firms in clusters benefit from interaction with TC firms, which can be seen as sources of know-how and expertise[1]. The role of TC firms as related and supporting industry and their likely contribution to achievement of national competitive advantage will be covered in the respective cluster studies of the research project, whereas the focus of the present study will be on the contribution of interaction with cluster parties to development of TC firms.

1.2. AIM, OBJECTIVES AND LIMITATIONS OF STUDY

Aim of the study is to describe and evaluate the effects of network interaction on development of technological know-how and expertise in TC firms. Development of TC firms' know-how and expertise is seen as technological development based on incremental innovations generated through diffusion, transfer and creation of technologies. Development of innovations through diffusion and transfer of technologies as well as through interactive learning process is enabled by interaction between TC firms and network parties.

To achieve the aim, following objectives are set:

1. to study the characteristics of industrial networks and interaction, development of innovations and industrial services
2. to identify the networks in which TC firms are involved, and to describe the interaction between TC firm and network parties
3. to evaluate the effects of interaction on technological development of TC firms, and to explore the process and mechanisms of the progress

[1]Porter 1990, 267

The study is limited to evaluate closer only the network interaction effects on the technological development. Other affecting factors such as own research activities, training programs and internal interaction synergies are described with less emphasis. Also, the study focuses on technological know-how and expertise in TC firms leaving the know-how related to project management outside the scope of the study.

1.3. RESEARCH METHODS

Effects of network interaction on technological development of TC firms are described and evaluated based on theories related to industrial networks, interaction, innovations and industrial services. Selection of interaction and network approaches for the basis of the study is supported by the characteristics of TC firm. TC firm is a knowledge and interaction oriented firm. It gathers, stores, adapts and develops further technological know-how flowing between it and customers, equipment manufacturers, research organizations and various other parties involved in technological development. It forms a link between business and basic research, and an interface where different technologies meet. Its role as a center of flows of information and technologies is further accentuated by the nature of the product, technical consultancy services involving expertise ranging from processes to equipments in different technological fields. Production and distribution of professional knowledge dominated service product require close linkages to the counterparts.

Due to the technological nature of TC firm's product, the firm's competitiveness is strongly based on development of technological know-how and expertise. It follows technological development and market forces in the field to be able to react to technical changes and shifts in customers' needs. It is assumed, that various and frequent linkages to different cluster parties are essential for development and sustaining of TC firm's technological know-how, expertise and competitiveness.

Empirical part of the study consists of four case studies basing on the theoretical part. The case firms are Finnish TC firms operating in energy sector and forest industries.

Theoretical part of the study bases on literature, principally books and articles, related to the topics. For empirical part information was gathered in firm interviews, and annual reports and other firm related material. Structure of the firm interviews is presented in Appendix 1.

1.4. STRUCTURE OF STUDY

In Chapter 2 the basics of industrial network and interaction theories are presented. Although Industrial Networks approach actually is an extension of Interaction Approach, the former is presented first because it is seen to form an essential framework in which interaction takes place. Interaction Approach was developed in the early 1980s by a European research team IMP Group (Industrial Marketing and Purchasing Group), and is thoroughly described in "International Marketing and Purchasing of Industrial Goods: An Interaction Approach" (1982) edited by Håkan Håkansson. Industrial Networks approach was developed some years later around Interaction Approach shifting the focus from the dyad to the network. A recent work providing an adequate presentation of the approach is "Industrial Networks: A

New View of Reality" (1992) edited by Björn Axelsson and Geoffrey Easton. Theoretical tools provided by the approaches will be described and utilized to the extent they serve the evaluation of interactive development process of innovations. Various extensions of both models have been developed after their emergence concerning e.g. different aspects of relationships, internationalization and technological development. Major part of the literature concerning interaction traditionally concentrate, for obvious economic importance, on supplier-buyer interaction. Network in following chapters is studied from a single firm's perspective, although many studies of the approach focus on networks at aggregate level.

In Chapter 3 the main characteristics of innovations and their development are presented. The interactive development process of innovations is described with emphasis. Network and interaction models are applied to depict technological development of industrial firms. In general, interest of researchers in development of innovations as a result of inter-firm interaction has recently been growing[2].

In Chapter 4 the principal actor of the study, TC firm as a provider of professional industrial services is presented. The model of interactive development process of technological innovations is applied to TC firms. TC firms in networks have also been in the focus of earlier studies. Sharma (1991, 1989) has studied international operations of Swedish TC firms and TC firm's work process based on network model.

Chapter 5 forms empirical part of the study and consists of four case studies. The model presented in Chapter 4 is applied to four Finnish TC firms operating in energy sector and forest industries.

Finally, in Chapter 6, conclusions will be drawn based on theoretical and empirical parts. Chapter 7 summarizes the whole study.

[2]Lundgren 1991, 95

2. INDUSTRIAL NETWORK - A BASE FOR INTERACTION

2.1. NETWORK

Network is a set of interactive relationships between organizations. A comprehensive description of industrial networks is provided by Industrial Networks approach developed in the 1980s. Basic elements of the approach are actors, activities and resources. Actors perform activities and/or control resources. They can be described in three dimensions based on the type of activities performed and resources controlled, and on the knowledge about activities, resources and other actors. An actor's principal aim is to increase its control and improve its position in the network.[3]

Activities performed by actors consist of combining, developing, exchanging and creating resources by use of other resources. The two main types of activities are transformation and transaction. Transformation is carried out under control of one actor, and involves improving one resource with the help of other resources. Transaction links together transformation, formation chains of activities, and creation of relationships with other actors.[4]

The basic elements in network are dependent on each other. The interrelatedness of the elements is presented in Figure 1 below.

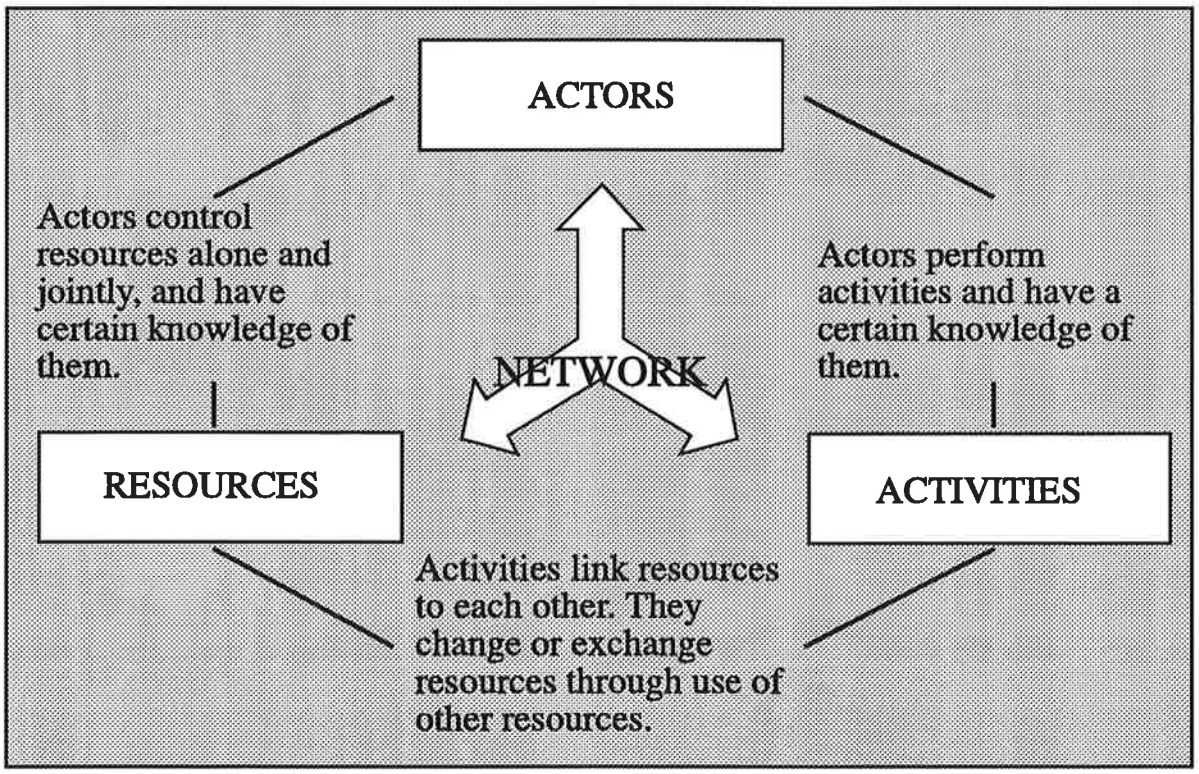

FIGURE 1: Network model
Adapted from Håkansson 1987, 17

[3]Håkansson 1987, 14-15
[4]Håkansson 1987, 15-16

Resources comprise physical, financial and human assets. Physical assets are for instance machinery and material, human assets labor, knowledge and relationships[5]. One actor's total resources are small compared to the resources controlled together by other actors, which pushes an individual actor to try to get access to these resources[6]. Consequently, importance of networks for an individual actor increases the more it is specialized and thereby dependent on complementary resources controlled by other actors[7].

All three basic elements of network model include technological dimension. Actors may adjust to, initiate or oppose technical changes, activities are technologically interdependent, and technology ties resources together.[8]

RELATIONSHIPS AS AN ELEMENT OF NETWORKS

A precondition for the functioning of networks is the existence of relationships. They enable actors to get access to complementary, external resources and thereby to manage the interdependent resources and activities. Relationships are valuable for the parties in industrial networks also because they increase productivity and technical efficiency through adaptations in products, production and deliveries, they serve as information channels, and as a way to increase control and power in a network[9]. Relationships involve simultaneously both conflicting and common interests. It takes time and resources to establish and develop relationships in industrial markets.[10]

Different kinds of bonds evolve over time in relationships. They indicate mutual interest of the parties. Technical bonds emerge between parties adjusted to each other in some technical sense. Time-based bonds emerge when there is need for temporal coordination between sequential activities of the parties. Knowledge-based bonds develop through exchange of information over time. Social bonds are based on personal contacts. Economic bonds are more formal relations such as investment and credits. Legal bonds are common ownership and contracts of all kinds.[11]

Distinction can be made between strong and weak ties[12], and direct and indirect relationships between actors. Strong ties are intensive and comprehensive relationships, whereas weak ties are less intensive and mostly used to obtain information from different areas. An individual actor in a network may have several weak ties as they do not demand large resources as strong ties do. Weak ties are complementary to strong ties and also potential strong ties. Indirect relationships are secondary relationships linked only to one of the parties and thus only indirectly to the other party[13].

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[5]Håkansson 1987, 16
[6]Axelsson 1987, 128
[7]Sharma 1989, 58
[8]Håkansson 1990, 372
9Håkansson 1987, 10
[10]Sharma 1989, 57-58; Håkansson 1990, 371
[11]Easton & Araujo 1989, 112; Biemans 1992, 88-89
[12]Biemans 1992, 145
[13]Johanson & Hallén 1989, 3

NETWORK POSITIONS AND DYNAMICS

Each actor has a certain position in a network defined by the functions performed by the actor for other parties, the relative importance of the actor in network, the strength of the relationships with other parties, and the identity of the parties with which the actor has direct or indirect relationships. A strong position is achieved for instance by controlling critical resources[14]. Positions in networks are consequences of earlier activities, and basis for the present and future activities. Establishment, maintenance and changing of positions takes time and effort.[15]

Networks are both stable and dynamic. They are stable because interaction takes place in an existing structure and network of relationships. Changes are caused by establishment of new relationships, and development and disruption of existing ones[16]. Network and its dynamics can be studied and analyzed from the perspective of an individual firm, or from the whole network's perspective at more aggregate level.

INDUSTRIAL NETWORKS

An industrial network typically consists of buyers, suppliers, competitors, complementary suppliers, consultants and research organizations[17]. Interactive relationships among network parties may be vertical such as between customers and suppliers, horizontal such as between competitors and complementary suppliers both serving same customers, and diagonal such as between research organizations and private firms[18]. Diagonal relationship implies that the parties belong to different domains, like universities characterized by academic mode of behavior and private firms characterized by profit-oriented mode of behavior[19].

Relationships between suppliers and buyers are strong, long-term, considered as investments, and built on cooperation, trust and loyalty[20]. They are based on strong common interest and mutual benefit. The vertical linkages contain greater knowledge transfer than other linkages. Competitors and complementary suppliers are more weakly tied and often bound in technological sense, as they adapt to each other's technical offerings. Links between competitors are mostly indirect and they involve conflicting interests. Relationships between complementary suppliers are indirect and often based on common interests. Time-based coordination is essential for them. The knowledge content in diagonal linkages is prominent. Social, financial and legal bonds emerge in a network in more arbitrary and random ways.[21]

Porter (1990) terms particularly successful and competitive industrial network "a cluster", which is one of the basic concepts in his work "The Competitive Advantage of Nations". Industrial cluster is defined as a group of mutually supporting competitive firms in various industries. The presence of clusters is characteristic for industrialized countries and advanced economies. They often emerge naturally and by themselves, but government can contribute

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[14]Melin 1989, 165
[15]Mattsson 1989, 122-123
[16]Johanson & Hallén 1989, xix; Sharma 1989, 58
[17]Sharma 1989, 57
[18]Easton & Araujo 1989, 114-115
[19]Lundvall 1988, 364
[20]Håkansson 1982, 14; Biemans 1992, 79
[21]Easton & Araujo 1989, 112

to evolution by reinforcing the formation or widening the existing cluster. Being an important part of the economy, a competent industrial cluster tends to gain attention from numerous instances in a nation. Universities and research institutes may focus their resources according to the cluster's needs. Its bargaining power in the economic life is strong.[22]

2.2. INTERACTION

Interaction is activities performed by network's actors to transfer, exchange, develop and coordinate interdependent resources. The driving force of interaction is the actors' aim to gain access to other actors' complementary resources through exchange and cooperation. In fact, networks are a result of interaction between organizations.

Interaction is of different character depending on industrial activities performed in an organization, counterpart, and resources needed in the activities. Interaction between parties develops and becomes closer and more effective over time through social exchange process. Exchange of information becomes more open and effective, and bonds of various kinds are formed.[23]

Interaction model is presented in Figure 2 below.

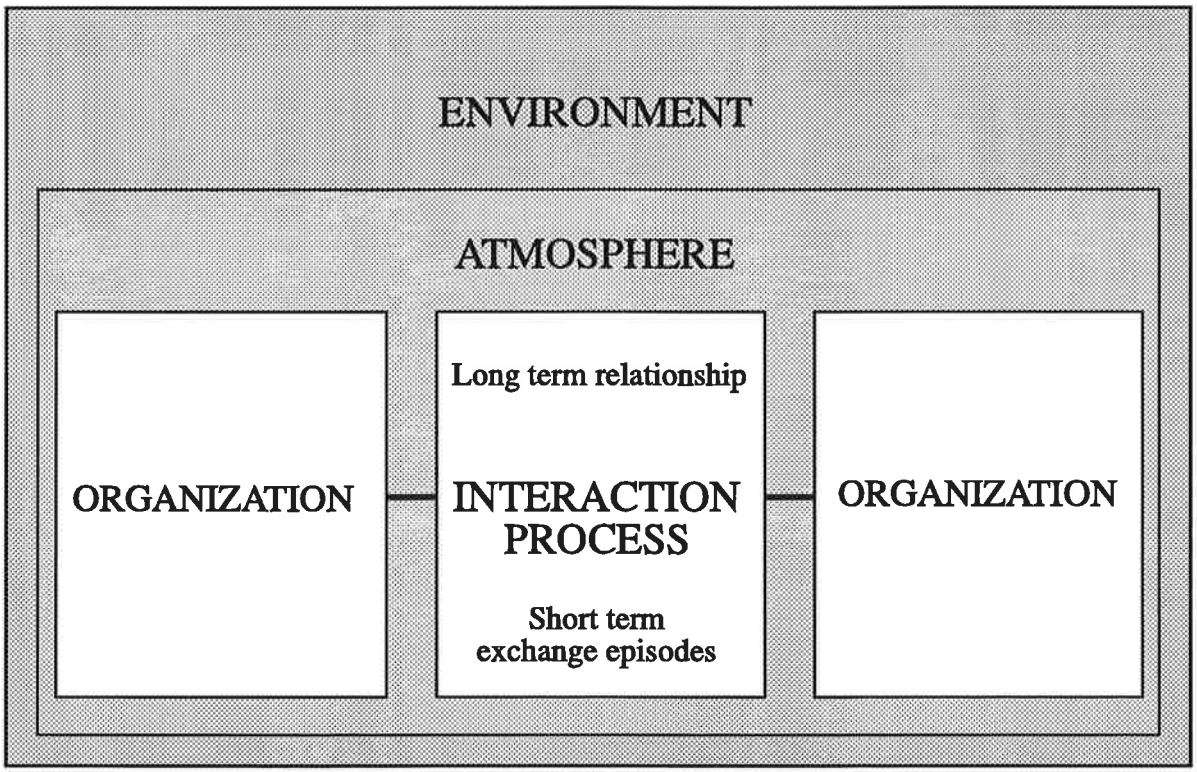

FIGURE 2: Interaction model
Adapted from Håkansson 1982, 24

A prominent model describing interaction in industrial markets is Interaction Approach introduced by the IMP Group in 1982. Whereas Industrial Networks approach concentrates

[22]Porter 1990, 149-151, 655
[23]Håkansson & Johanson 1988, 372-373; Lundvall 1988, 356

on set of linkages among several actors, Interaction Approach focuses on dyadic interaction between buyers and suppliers. According to the interaction model interaction consists of four elements: process, parties, environment and atmosphere. Process is defined as short and individual exchange episodes and as a long-term relationship including adaptations and institutionalization. The parties affect the process with their characteristics as organizations (e.g. technology, products offered) and as individuals (e.g. experience, motivation). The environment contains aspects like market structure, dynamism and social system. The atmosphere of the relationship is considered as a group of intervening variables defined for instance by the characteristics of companies and interaction process.[24]

EXCHANGE OF RESOURCES

Exchange of interdependent and complementary resources between two parties typically includes products and services. The content, width, depth and formality of information in exchange is determined by the technical, economic and organizational importance of exchange. Financial exchange indicates the economic importance of the relationship. Social exchange reduces uncertainties between the two parties and is critical in the build up of long-term relationships. Most interaction involve several of the above assets, that is products, information as well as financial and social elements. Interaction including mutual exchange of resources between two organizations is most successful when both parties derive benefit from it.[25]

COOPERATIVE INTERACTION

All interaction between industrial firms includes cooperation to certain extent. Cooperation can be effective in situations where the firms have both common and conflicting interests. Formal cooperation is visible, does not often lead to real cooperation based on trust, and is usually entered into at a higher management level with relatively high involvement of staff. Informal cooperation is more invisible and based on trust developed through social exchange, and is developed by those directly involved in the business exchange between firms.[26]

Formal cooperation takes usually place in order to gain economies of scale. In vertical interaction it can be for instance a joint activity in which certain production or distribution is carried out together[27]. Technical cooperation is a very common type of cooperation both in vertical and horizontal interaction.

COMPLEMENTARY REMARKS ON INTERACTION

Melin (1989, 176) makes a distinction between instrumental/transactional and social commitment sides of interaction, and consequently regards interaction as being based on both instrumental and social motives. The two dimensions determine the stability and change in industrial networks. Change is seen to emerge from unsatisfactory outputs in economic transactions, and the stability to be shaped by social relationships. Instrumental interaction is

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[24]Håkansson 1982, 14-22
[25]Håkansson 1982, 16-17; Biemans 1992, 140-141
[26]Håkansson & Johanson 1988, 374-375
[27]Karlsson 1988, 159

considered to have an identified lifespan, whereas social interaction process is considered to take time to develop to have no end decided in forehand.

Porter (1990, 153) has identified incentives to interaction in a network. Factors such as personal relationships, ties through a scientific community or professional associations, common ownership within an industrial group and interlocking directors are considered to facilitate the exchange and flow of information.

3. DEVELOPMENT OF INNOVATIONS THROUGH INTERACTION IN INDUSTRIAL NETWORKS

3.1. INNOVATIONS

Innovation is an invention introduced into a market[28]. It is mostly considered to be technological including novelties and improvements in products and production techniques, but it can also be defined as new ways of marketing and distributing[29]. Innovations can also mean organizational, social and institutional novelties, as well as the whole process of creating, diffusing and using these changes[30]. In the following the focus will mainly be on technological innovations, which, however, in themselves may include for instance organizational and social innovations.

Most of the innovations in firms are rather mundane and incremental than radical. Incremental innovations are relatively continuous, small scale improvements on the existing range of products, processes and organizations. Radical innovations are discontinuous events, whole new ways of thinking, and involve both technical and organizational changes. They are for instance new base technologies which affect many other technologies.[31]

Technological innovations are usually divided into product and process innovations. Product innovations are defined as new technologies commercialized to satisfy the market needs. Process innovations are defined as equipment, methods and systems employed to produce these products. Process innovations are often incremental in nature, as production processes typically develop gradually towards higher level of performance.[32]

Innovations are an essential element in technological development at both macro and micro levels of economy[33]. In an individual firm technological innovations are an inherent part of technological development, development of technological know-how and expertise. In the present study the development process and mechanisms of technological innovations are seen analogous with those of technological know-how and expertise.

3.2. DEVELOPMENT OF INNOVATIONS

Firms are prompted to explore and develop innovations because of the economic benefit conferred by yet unexploited scientific and technical opportunities and their market potential[34]. Consequently, industrial competitiveness is enhanced by technological innovations[35].

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[28]Biemans 1992, 9
[29]Biemans 1992, 10
[30]McKelvey 1990, 2
[31]Freeman 1989, 21
[32]Laage-Hellman 1987, 26-27
[33]cf. Lemola & Lovio 1984, 9-11
[34]Dosi 1988a, 1120
[35]Dosi 1988b, 221

A firm develops innovations and thereby its know-how and expertise basically through inventing and imitating. Innovations through original inventing give firm a temporary monopoly advantage over competitors, whereas imitation is adoption and adaptation of innovations already introduced by others[36]. Porter (1985, 181) terms the former "technological leadership strategy" and the latter "technological followership strategy". Incentives to followership strategy are lower costs by learning from leader's experience and avoiding the R&D costs. Reasons for choice of different innovation strategies are found in the firms' varying capabilities and resources[37].

INVENTING INNOVATIONS

Important sources for original inventing of both incremental and radical innovations are formalized research activities and accumulating experience, i.e. "learning by doing and using"[38] and experience. Lundvall (1988), seeing innovation not only as a technological novelty, argues that innovation results in capitalistic systems from normal economic activities. According to him developing innovations is an on-going process of learning, searching and discovering in routine production, marketing and routinized research activities[39].

In addition to the above intra-firm factors the role of external factors as contributors to the innovating process are increasingly emphasized. External sources of innovations are for instance new opportunities created by advancement in science and technology, i.e. "science push", and customers' new needs, i.e. "market demand"[40]. External acquisition of technology may also be considered a source of innovation, including for instance license agreements or acquisition of firms possessing the desired knowledge[41]. Recruiting skilled personnel can also be seen as acquiring external resources for creation of innovations. Contribution of all types of internal and external factors to the creation of innovations is simultaneous and overlapping.

The importance of experience in producing technological innovations is justified by the fact, that a major part of scientific-technical know-how is not public information which can easily be imitated and exploited. Instead, much of technological know-how and expertise can only be gained through experience. It is specific to firms and applications, cumulative in development and varies amongst industrial sectors in source and direction. Creation of innovations is thus dependent on the technological level achieved earlier.[42]

IMITATING INNOVATIONS

Developing innovations through imitating means adopting and adaptating innovations created by other firms[43]. It is an integral part of diffusion of innovations and technologies,

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[36]Pavitt 1988, 126
[37]Lemola & Lovio 1984, 12
[38]Dosi 1988a, 1124-1125
[39]McKelvey 1990, 14
[40]Lemola & Lovio 1984, 27
[41]Chesnais 1988, 510
[42]Pavitt 1984, 343; Lovio 1986, 10
[43]Pavitt 1988, 126

which can be defined as process in which new techniques spread among the potential users[44].

Diffusion of technological innovations occurs actively and passively simply through direct observation and technology transfer, and through equipment suppliers, buyers, consultants and trade press[45]. Whereas diffusion can be both intentional and unintentional process, transfer is always intentional and planned, and occurs in cooperation between two parties[46].

Although diffusion studies have mainly been focused on radical innovations[47], incremental innovations are an essential element in diffusion process. Innovations are usually continuously modified and improved thereby producing incremental innovations throughout the diffusion process[48]. A large part of created innovations are actually adaptations of and incremental improvements on innovations imitated from others. The success of imitating technological innovations depends on the imitating firm's ability to produce or replicate the innovative results, which, in turn, is dependent on the firm's existing range of technological and marketing skills[49].

Diffusion of technology is more intensive concerning basic product and process innovations than later incremental improvements. Diffusion can be partially hindered through patenting, secrecy, in-house development of prototypes and production equipment, vertical integration into key parts that embody or give clues to the technology, and personnel policy that retain employees.[50]

3.3. INTERACTIVE DEVELOPMENT PROCESS OF TECHNOLOGICAL INNOVATIONS

Based on the above, development of technological innovations in an industrial firm consists of inventing and imitating of innovations, and is reflected by technological development of the firm. The process of technological development is mostly gradual based on incremental improvements on the existing and imitated technological innovations. The focus in the following subsection will be on inter-firm interaction as a contributor to technological development and innovations in industrial firms.

Håkansson (1990, 373) considers relationships and interaction with different counterparts important for a firm's technological development. Technological innovations are seen as a result of interaction between parties instead of consequence of one actor's performance[51]. Also Biemans (1992, 5), partially relying on the studies of Håkansson, assumes relationships to be of primary importance in developing technological innovations in industrial networks. He stresses the contribution of interaction among several actors instead of between two[52]. The above views are supported also by Karlsson (1988, 159), who sees elaborating external

[44]Vuori & Ylä-Anttila 1992, 7
[45]Porter 1985, 185
[46]Vuori 1991, 1
[47]Freeman 1989, 21
[48]Brown 1981, 174
[49]Dosi 1988a, 1131
[50]Porter 1985, 185-186
[51]Håkansson 1987, 1-3
[52]Biemans 1992, 82

network by more intimate ties with other parties essential to enhance the technical development capability.

Lundvall (1988) considers interactive learning of user and producer as a center of innovation process. Interaction enables the actors to learn and hence to innovate the user communicating potential needs (demand pull innovation) and the producer potential technical opportunities (technology push innovation)[53]. The concept "learning by doing and using" is widened to also cover "learning by interacting"[54]. According to Lundvall, the effectiveness of user-producer relationships grows through experience in interaction, as the elements of hierarchy and mutual trust become stronger and the exchange of information more open[55].

The importance of inter-firm interaction for technological development and innovations is based upon three phenomena. Firstly, new knowledge often emerges at the interface between different knowledge areas, as new thoughts are basically created by combining two or more already existing ones[56]. Secondly, success of technical novelty is dependent on the support it generates among other actors increasing chances for acceptance. Thirdly, increasing specialization among industrial firms drives them to complement and coordinate their own resources with others' resources.[57]

All in all, interactive development process of technological innovations consists of diffusion and transfer of technologies, and of creation of new technologies as a result of interactive learning process, all the above enabled by interaction between organizations.

PASSIVE AND ACTIVE INTERACTION

Interaction among network parties leading to development of innovations may be passive or active depending on its intensity. Passive interaction concerns unplanned and occasional acquisition of resources, mostly information on new technologies or new customer needs. It includes for instance normal diffusion of knowledge through interaction with network parties, and improvements on products and processes as a result of daily customer-supplier interaction. Active interaction concerns active and planned acquisition of resources for development of innovations, often guided by predetermined objectives. It includes for instance visiting and interviewing suppliers, customers and other parties, technology transfer, technical cooperation or actual joint development projects with them.[58]

Interaction may also be characterized by the degree of formalization depending on the type of counterpart and situation. The degree of formalization does not necessarily correspond to the intensiveness of interaction.[59]

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[53]McKelvey 1990, 15
[54]Lundvall 1988, 362
[55]Lundvall 1988, 356
[56]Karlsson 1988, 158
[57]Håkansson 1987, 4-5; Håkansson 1990, 372-373
[58]Biemans 1992, 143-144
[59]Biemans 1992, 147

TECHNICAL COOPERATION

Technical cooperation is the most common type of active interaction among network parties generating industrial innovations. It encompasses vertical cooperation between customers and suppliers, horizontal complementary cooperation between complementary suppliers, horizontal competitive cooperation between competitors, and diagonal cooperation between private firms and research organizations[60].

Cooperation between customers and suppliers is intensive and informal, part of the ongoing relationship. The long-term and close vertical relationship between industrial firms facilitates flow of information. The supplier has an opportunity to enhance its knowledge about customer needs and develop its technological know-how and expertise along new products, whereas the customer benefits from getting better fitting products. They can help each other to perceive new methods and opportunities to apply new technology through revising and redefining needs and solutions. They have quick access to each other's information, new ideas and insights, and innovations. Most of the technological innovations generated are everyday improvements on existing products and production technologies.[61]

Technical cooperation between complementary suppliers concerns interaction between suppliers who serve the same customer. This interaction has same kind of natural basis for cooperative activities as the interaction between customers and suppliers, but it lacks repetitive daily contacts. Cooperation is typically very formalized and often focused on a specific project solving a particular technical problem, taking advantage of a special opportunity or to gain economies of scale. This implies that innovations may be more radical. Horizontal complementary cooperation can lead to establishment of closer relationship and interaction.[62]

Technical cooperation between competitors is also very formalized and more project oriented. Relationship often stays distant as there is no basis for daily activities connecting companies. Cooperation usually aims at creation of major process innovations.[63]

Research organizations play an important role as producers basic knowledge in industrial fields and transmitters of existing knowledge within the network. The less the firms have own research resources, the more they are dependent on the outside research resources possessed by research institutes and universities[64]. Cooperation with research institutes is usually R&D cooperation focused on creation of more radical innovations in products and processes.[65]

There is an growing interest towards technical cooperation and other interaction between university and industry, basic and applied research, as the role of science in relation to technology and production has been recognized. A prominent example of close interaction between universities and industrial firms leading to technological development is "Silicon Valley". Nowadays most OECD countries aim at establishment of "science parks" and

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[60] Håkansson 1987, 6
[61] Håkansson 1987, 7; Laage-Hellman 1987, 29; Porter 1990, 103
[62] Håkansson 1987, 7-8
[63] Håkansson 1987, 7; Laage-Hellman 1987, 28
[64] Lovio 1988, 38
[65] Laage-Hellman 1987, 28-32

"technopolises" in order to enhance the productive interaction among firms and universities.[66]

IMPORTANCE OF EXPERIENCE AND INDIVIDUALS

To effectively use external linkages for enhancement of its technological development, a firm must know the network in which it is involved. A firm needs to know where to find different resources, the roles played by different parties, and how to use particular resources. This knowledge can be acquired by interacting in network and by participating in its technical development.[67]

The smallest links in industrial networks are formed between individuals, who are especially important for the forms of information exchange which often occurs in technological development. Individuals are important because they are the actual discoverers of possibilities, transmitters of information, and mobilizers and organizers of resources through personal contacts.[68]

Interactive relationships among firms may also hinder technological development and innovations because of the interdependencies among industrial firms. Technical dependencies are caused by the fact that individual products are used together with other products in a network. Knowledge related dependencies arise because the customer needs a certain knowledge of the product supplied to be able to use it. Social dependency concerns the terms of values, norms and legitimization approved in a network.[69]

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[66]Lundvall 1988, 364
[67]Laage-Hellman 1987, 42
[68]Hamfelt & Lindberg 1987, 177-179
[69]Håkansson 1987, 92-93

4. TECHNICAL CONSULTANCY FIRMS AND TECHNOLOGICAL DEVELOPMENT IN NETWORKS

4.1. INDUSTRIAL SERVICES

Services are more or less intangible products, activities or series of activities, which occur in interactions between customer and service provider. They are produced and consumed simultaneously, and customer may participate in the production process. Services are specialized as they can be customized to customer's needs, and heterogeneous due to the variability of services performed.[70]

Industrial services are those provided to organizations, businesses and institutions instead of individuals and households[71]. Industrial services are bought to replace an activity currently performed internally or to supplement present activities in industrial firm[72]. In industrial marketplace the buying process is rationalized, and larger amounts of money are involved. The relationships are longer-term and formed among more people and more procedures. The products involved are technically more complex, often unique to a single organization, and buyers and suppliers may be forced to work together on design and specifications.[73]

Industrial services are increasing along the growth of the whole service sector. Industrial firms need more sophisticated services due to complexity of their products and operations. Technological development and regulatory changes may create whole new fields of services[74]. Service activities are being deintegrated in order to raise flexibility of operations and to lighten the organization, and because the specialized service providers are increasingly competitive compared to in-house units.[75]

The growth in supply is facilitated by the ease of entry on the non-oligopolistic market of industrial services. Imitation and new competition cannot be hindered by patents of the established firms, and the human-intensive character of service industries lowers capital requirements for entry[76]. Intangibility makes services easy to develop and thereby creates opportunities for new or modified services[77].

Professional industrial services are those provided by specialist firms established to carry them out. They are unique and supplemental in nature. Services are provided by qualified personnel independent of suppliers of other services or goods.[78]

Gummesson (1978) has studied marketing and purchasing of professional services in Sweden, and has identified four necessary components in professional services: 1. specialist know-how and experience, 2. individual professionals with their ability to interact between

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[70]Cooper & Jackson 1988, 53; Grönroos 1990, 29
[71]Rathmell 1974, 11
[72]Rathmell 1974, 188
[73]Cooper & Jackson 1988, 52
[74]Grönroos 1990, 13
[75]Porter 1990, 241-243
[76]Rathmell 1974, 192-193
[77]de Brentani 1989, 241
[78]Gummesson 1978, 90; Grönroos 1990, 8

themselves and customers, 3. way of operating the assignment varying e.g. in period of time and degree of cooperation, and 4. solution to the problem being a written report or non-written recommendations.

4.2. TECHNICAL CONSULTANCY FIRMS

Technical consultancy (TC) firms provide professional industrial services. They produce specialized, heterogeneous and skill intensive services in close interaction with customers, with whom the relationships are usually long-term.

Technical consultancy may also be called consulting engineering, engineering consultancy or simply consulting, engineering or design. The definitions are to a great extent overlapping and firm-specific, and no clear terminology has yet been created. Some TC firms make clear distinction between consulting and engineering the consulting referring to problem evaluation and search for solution, and engineering concerning the actual detailed engineering. All in all, technical consultancy ranges from feasibility studies, planning, basic and detailed design to turnkey projects including contracting and project management.

TC firms operate for instance in sectors of production and infrastructure in the areas such as energy, process, plant and electrical engineering. They serve industrial firms as capacity regulators allowing them to benefit from leveling staffing or, more important, as external specialists to reduce risk in the operational areas where the customers themselves have little or none of technological expertise and experience[79]. TC firms differ along the technology dimension some specializing in a single or limited number of functions and some being multispecialty firms.

PRODUCT BASED ON EXPERTISE AND INTERACTION

TC firms' products obviously have high technology content. The services are based on specialist technological know-how, expertise and experience. Knowledge of the latest development in the technological field including processes, equipment and skills is precondition for the existence of TC firms[80]. Unique technological capabilities offer a TC firm an opportunity to gain competitive advantage.

Being professional, special and people based service, technical consultancy requires a significant customer interface, and frontline personnel is of special importance. The consultants need the ability to see, understand and evaluate customers' problems and find the right solutions for them. The success of the assignment is dependent on close and continuous interaction between the consultant and customer. Effective interaction facilitating a proper interpretation of the advice and recommendations is enabled through established and stable relationships[81].

Technological expertise as well as the communicative and innovative skills are TC firms' most important resources. As they are all embodied in the personnel, the role of personnel in

[79]Davidson 1974, 210; Sharma 1991, 60
[80]Sharma 1991, 32
[81]Sharma 1991, 23

TC firms' utmost important. Professional and skilled labor produce the output of TC firms and correspond to the technical core of manufacturing firms[82].

TECHNICAL CONSULTANCY AND MANUFACTURING INDUSTRIES

TC firms are organized as independent firms or as business units in larger industrial firms. Business unit type of TC firms obviously derive their technological know-how, expertise and experience from the parent company's operations and processes. Some of them do not provide services to outside customers, as they are maintained to carry out complex assignments and project management responsibility only inside the parent company. Manufacturing firms also attach services such as technical consultancy to the sales of goods expanding the product offer from goods to systems in order to gain competitive edge[83]. This makes manufacturing and service industries increasingly intertwined.

The industrial structure influences the sophistication of TC firms in a nation[84], as TC firms' sales are strongly dependent on industrial firms' demand. In the sectors with significant home demand new specialized suppliers are more prone to emerge to satisfy the new and growing needs of a strong sector[85]. Sales of industrial firms may also create demand for associated technical consultancy services, and the sales of technical consultancy services may lead to demand for equipment and other associated manufactured goods. The increasing number of TC firms is closely associated with the industrial and economic development of a country[86].

COMPETITION IN TC SERVICE SECTOR

Along the development and growth in industrial and other service sector, the competition has grown and become more international. For instance, TC firms do not only face competition with other TC firms in the field, but also with manufacturing firms selling systems. In general, the TC market is competitive due to the nature of its products as services. They are easily imitated, developed and modified, and thereby any competitive advantage is rapidly eliminated[87]. However, imitation is to some extent hindered through the expertise required in products.

Reasons for growth in international competition in TC services can be found on one hand in similarity of needs in most of the world, and on the other hand in dissimilarity of services available from local firms[88]. Technology needed for certain process plant is the same in all countries, but only few countries have the sufficient expertise and know-how to produce it. International competition is keener in the segment of large-scale projects and sophisticated industrial facilities than in small plant projects[89].

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[82] Sharma & Johanson 1987, 21
[83] Gummesson 1984, 126; Grönroos 1990, 3
[84] Porter 1990, 253
[85] Sölvell et al. 1991, 50
[86] Sharma 1991, 40
[87] de Brentani 1989, 242
[88] Porter 1990, 251
[89] Porter 1990, 268

4.3. TC FIRM IN NETWORK

TC firm can be characterized by an interactive nature of its operations. The service product in itself requires interaction for its production and distribution. Because of the skill intensiveness together with high knowledge content and degree of customization the service requires close and effective interaction to be successfully provided. Operating in industrial markets the relationships are by their nature stable and long-term facilitating effective interaction. Moreover, the service involves expertise in different technological fields, which may require linkages to several parties in various industries. Last but not least, TC firm is dependent on interaction with other firms because of the specialized nature of its operations. It needs exchange with specific parties to gain complementary resources[90].

Resulting from interaction with various parties, a TC firm can be seen to operate in a network of industrial firms and other organizations. The network generally consists of customers, manufacturers of equipment and machinery also termed as complementary suppliers, complementary consultancy firms and competitors, and research institutes and universities. The relationship with equipment manufacturers can be either vertical buyer-supplier or horizontal complementary suppliers relationship depending on which party is in response of the purchase of equipment for the assignment.

TC firm has a certain position in a network, in which it executes certain functions such as supply of specialized skills and know-how, independent evaluation and advice, and discovery of fresh approaches to a problem[91]. TC firm's interaction with network parties varies from passive and occasional exchange of resources to more active and intensive cooperation, the emphasis, however, being on the cooperative and intensive nature of interaction due to the characteristics of the service provided. Moreover, interaction with customers easily becomes regular if the assignments prove to be successful, because customers value good references and experience in the absence of tangibility of the product provided. Technological, knowledge-based and social bonds easily emerge in interaction.

The most important linkages in the network are the relationships with customers, equipment manufacturers and research organizations. Interaction is principally cooperative of a nature, and social and information exchange are prominent in the process. Relationship with customers can be characterized as strong tie, as it tends to be close enabling effective interaction to guarantee the success of assignment. Equipment manufacturers often take actively part in TC firm-customer interaction during the project. This is essential for finding the right equipment and machinery for the optimal solution in the assignment. TC firm interacts with equipment manufacturers also outside the actual projects, but interaction is then more passive and less intensive. The relationship with research organizations is rather weak but important to gain information on basic research in technological fields as TC firms do not usually conduct own basic research. Interaction with research organizations is at its most active during formal technical cooperation. Relationships with complementary consultancy firms and competitors are mostly weak and indirect.

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[90] Sharma 1989, 58
[91] Sharma 1991, 41

TC firm interacting in a network is presented in Figure 3 below. Network is illustrated from TC firm's perspective.

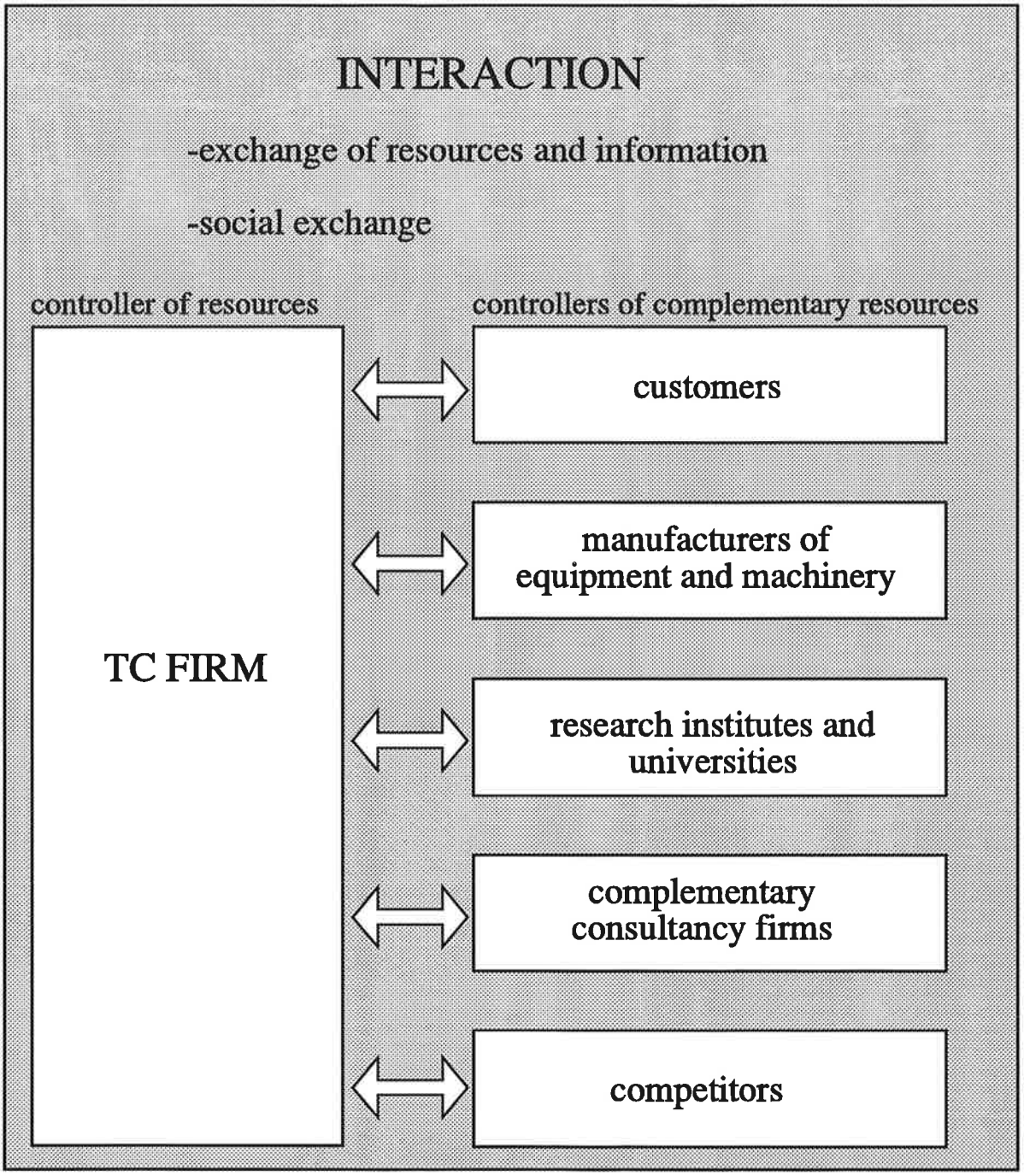

FIGURE 3: TC firm interacting in network

NETWORKS IN TC WORK PROCESS

Different networks of relationships are needed in the different phases of the technical consultancy work process. Seven phases of the work process have been distinguished, each characterized by a distinctive need for relationships with outside firms.[92]

[92]Sharma 1989, 58

The relationships in the first phase, preparing a master plan, satisfy the need for expertise. A widespread network of experts in universities, research units and so forth is essential. Prefeasibility and feasibility studies and basic design in the second and third phases require relationships with equipment producers and complementary consultant firms. The fourth phase, detail design and tender documents, should include the same contacts as in the preceding phases, but only fewer. It is a more inward oriented phase requiring mainly internal specialists. Negotiations and control in the fifth and sixth phases still include the earlier contacts but fewer, and the last, start and operation phase, additionally requires the managers.[93]

The needed relationships during TC firm's work process are presented in Table 1 below.

Phases	**Relationships**
Master plan	Expertise
Prefeasibility	Local firms
and feasibility	Equipment producers
	Other consultants
	Financial institutions
Basic design	Equipment producers
	Laboratories
	Other consultants
	Users
	Architects
Detail design and	The same but fewer
tender documents	
Negotiations	The same but fewer
Control	The same but fewer
Start and operations	Managers

TABLE 1: Relationships during TC firm's work process
Source: Sharma 1989, 59

Network relationships are ultimately formed between individuals, which are very important for TC firms as effective interaction is dependent on the communicative skills of personnel of both parties. However, firm-level relationships go beyond the reach of individuals and have effects of larger scale. Firm-level and individual-level relationships complement each other.[94]

4.4. DEVELOPMENT OF TC FIRM'S TECHNOLOGICAL KNOW-HOW AND EXPERTISE THROUGH NETWORK INTERACTION

Development of a TC firm's know-how and expertise is based on technological innovations, rather small and incremental than radical, developed through imitating and inventing. A major part of the innovations are actually slight improvements on the innovations imitated from others. Only rarely does a TC firm come up with truly radical invention and innovation, as it does not conduct basic research.

[93]Sharma 1989, 59
[94]Sharma 1989, 73

TC firm's role as a center of flows of information and technology is emphasized by the interactive nature of its operations. TC firm continuously gathers, develops and sells further technological know-how and expertise through interaction with various parties in a network. It accumulates its know-how and expertise through simply collecting skills, technology and information from other parties through its operations and typically intensive interaction during the assignments and outside them. A TC firm continuously gains insights into a field and obtains feed-back, which enables its services to improve and vary. Finding fresh and new approaches to different technological problems and integrating new knowledge is actually TC firm's job, as it is trained to uncover new ways of doing things[95].

The most important linkages in the process of technological development through interaction are relationships with customers, equipment manufacturers and research organizations. Every implemented project contains technical cooperation among the customer, equipment manufacturer and TC firm, and leads to a new product innovation, a solution to customer's problem. More passive interaction with customers and equipment manufacturers outside the actual projects also provides a channel for diffusion of technologies and innovations. Despite the occasional close cooperation with equipment suppliers TC firms consider important to maintain their independence from them.

The dependency on outside parties in the enhancement of TC firms' technological know-how and expertise is emphasized by the uniqueness of its resources and by the fact that TC firms undertake little or no independent basic research[96]. They rather conduct applied research, and act as a linkage between basic and applied research. It is therefore essential for them to passively and actively interact with research organizations to gain information on development of basic scientific principles, and be able to innovatively adjust the applied principles to their services rendered.

Complementary consultancy firms' and competitors' role in the process of TC firm's technological development is basically to be participants in the innovation diffusion process in networks.

Experience, which also can be called learning by doing, is another important contributor to a TC firm's technological development. It is closely related to interaction, as experience can only be gained through implementing projects, which in their turn are based on effective interaction. Effects of experience can to certain extent be seen intertwined with effects of interaction. However, experience is not totally dependent on receiving information from other parties. It rather concerns internal accumulating of skills, know-how and expertise. Experience together with reference projects are at their most important from the marketing point of view.

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[95]Sharma 1991, 42
[96]Sharma 1991, 32

Development of TC firm's know-how and expertise through interaction with network parties is presented in Figure 4 below.

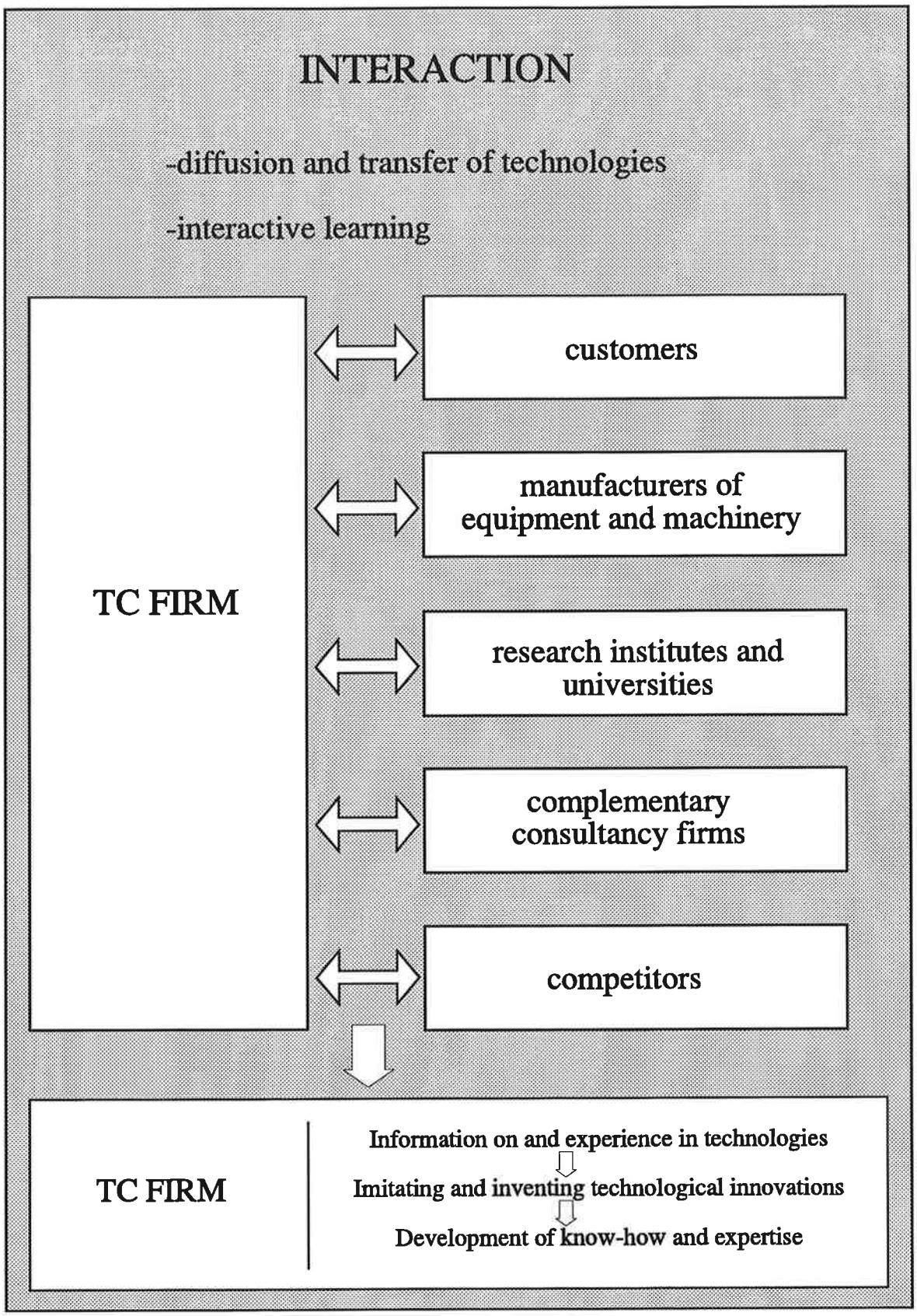

FIGURE 4: Development of TC firm's technological know-how and expertise through interacting in network

5. CASE STUDY: EFFECTS OF NETWORK INTERACTION ON DEVELOPMENT OF KNOW-HOW AND EXPERTISE IN FOUR FINNISH TC FIRMS IN ENERGY SECTOR AND FOREST INDUSTRIES

5.1. CASE 1: IVO INTERNATIONAL LTD

IVO International Ltd was established in 1981 as a subsidiary of IVO Group under IVO Engineering business unit. It markets and sells the Group's energy expertise to customers outside IVO on both domestic and foreign markets. Its turnover in 1991 totalled FIM 233.5 million, foreign projects accounting for FIM 56 million and domestic for FIM 177.5 million[97]. In 1993 IVO Engineering was integrated to its subsidiary IVO International. Since then IVO International's customers comprise also the rest of IVO Group. IVO Engineering's turnover in 1991, including also figures of IVO International, totalled FIM 1.462 million, and the number of employees was 1560[98].

Today the company's services include for instance consulting and engineering for power generation and transmission projects, and operation and maintenance services for power plants. Thermal power engineering covers design of power plants using natural gas, coal, oil, peat and wood waste as principal fuels.

The focus of the case study will be on the part of the present IVO Group that during its organizational history has been in response of providing technical consultancy services in thermal power engineering to customers both in and outside the IVO Group, and thereby possesses the know-how and expertise related to it.

DEVELOPMENT OF FIRM'S OPERATIONS

Before the actual sales of know-how and expertise to customers outside IVO, thermal power plants were for decades designed for own use. The first thermal power plant was constructed in the late 1930s to satisfy a growing energy need of paper and mining industry and enlargening towns[99]. All the equipment and machinery for the plant were supplied by foreign manufacturers. Further construction of thermal power plants during the following five decades was induced by different factors such as growing demand for electricity in the southern parts of Finland, low prices of oil and coal, and Neste's start of operations in oil and later in natural gas business[100]. In the subsequent projects domestic manufacturers were increasingly involved, although a major part of equipment and machinery continued to be imported for several decades.

A vast majority of thermal power plant projects were implemented in Finland and mainly for IVO itself, although sales to customers outside IVO increased after the formalization of

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[97] IVO International Ltd Annual Report 1991, 3
[98] IVO International Ltd Annual Report 1991, 2
[99] Auer & Teerimäki 1982, 74-76
[100] Auer & Teerimäki 1982, 155-158, 165

consulting operations in the 1980s. There are very few foreign projects in thermal power engineering.

NETWORK AND INTERACTION

The main actors within IVO International's network are customers, manufacturers of equipment and machinery, competitors, research institutes and universities, and complementary consultancy firms. The network environment is affected by the state sector and pressures to environmental protection. The strong effect of state sector is obvious, as the whole energy sector and not the least the state-owned IVO Group are both state-controlled. The pressures to environmental protection in energy sector have significantly increased in the 1980s.

The majority of **customers** in thermal power plant projects have always been domestic, and mainly the IVO Group itself. In some projects customer firm has been formed through a joint-venture IVO participating with 50%. The number of projects for customers outside IVO increased somewhat in the 1980s along the formalization of consulting operations. Domestic customers in thermal power engineering have mostly been utility companies. Due to the declining demand for power plants in Finland in the 1990s the share of foreign customers is planned to be increased[101].

The relationship and interaction with the owner IVO Group cannot be considered normal and objective buyer-supplier interaction. On the other hand, such long-term and close a relationship offers opportunities for utmost close, cooperative and synergistic interaction and free flow of information.

IVO International aims at close and cooperative interaction with all customers to guarantee efficient exchange of information and thereby success of the project. IVO International considers the customers in energy field utmost conservative requiring reliable and conventional solutions for their energy need. The only major change in the customers' demand in the 1980s has been caused by pressures to environmental protection.

During the first decades **manufacturers of equipment and machinery** were mostly foreign. They all had representatives in Finland, which facilitated establishment of close relationships. IVO's role in interaction with equipment manufacturers rapidly turned from passive receiver of technologies to more active as its know-how and expertise accumulated. Along the years and development of Finnish manufacturer industries domestic participation in projects increased.

Relationships and interaction with equipment suppliers are close and cooperative in each project. In most projects interaction includes simultaneous interaction with both equipment manufacturers and customers. Interaction with manufacturers is regular but more passive outside the actual projects.

Interaction with equipment manufacturers has occasionally been even more intensive and cooperative when IVO International has implemented joint-research projects with domestic and foreign manufacturers in new and crucial areas of technology. Particularly in

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[101] Imatran Voima Annual Report 1991, 5

environmental technology the company nowadays aims at formal joint-research projects with manufacturers instead of pure purchase of equipment. IVO International considers own R&D activities a prerequisite for joint-research projects, as a partner's know-how cannot be exchanged for money but for own know-how developed through own R&D.

The main **competitor** on the domestic market today is Ekono Energy Ltd. Through IVO Group IVO International is a member of the ETY Association (Energiataloudellinen Yhdistys), an initial owner of the competing firm. Until the 1970s IVO mainly concentrated on its own projects and Ekono Energy served the private sector. Along IVO's enlargening consulting operations for customers outside the Group the competition has become keener.

IVO International interacts actively with both domestic and foreign **research institutes and universities**. The company has regular contacts to both the Technical Research Centre of Finland VTT and the Helsinki University of Technology TKK. Interaction with the VTT is at its most intensive in joint-research projects in new and progressive areas of thermal power engineering. In 1992 a cooperation agreement was signed with a major British energy research centre active in the field of fuel cell technology. IVO International has also recently established a contact to a USA based research institute operating in the field of thermal power engineering and environmental technology. IVO Group's and IVO International's linkage to an important Germany based association in energy sector, VGB (Technische Vereinigung der Grosskraftwerksbetrieber e.V.), is coordinated through the ETY Association.

IVO International considers different forms of formal cooperation important in today's business. An example on this development is IVO International's 40% participation on **a complementary consultancy firm's**, Jaakko Pöyry Group's international operations since 1992.

DEVELOPMENT OF KNOW-HOW AND EXPERTISE

All the technology was originally imported for IVO's first project in the 1930s. Nevertheless, along the growing number of projects and increasing experience IVO accumulated its know-how and expertise and took more responsibility for the total design of plants. Much of the present know-how and expertise in thermal power engineering has developed through experience along planning, operating and maintaining of IVO's several own thermal power plants. The basic know-how in power plant engineering was also derived to some extent from the earlier experience in hydro power plants. The huge and long-term project for construction of nuclear power plant during the 1970s had also a strong impact on this development.

In the development of technological know-how and expertise through interaction the relationships with customers, equipment manufacturers and research organizations have been the most important. Technological development has been enabled by close and cooperative interaction with domestic **customers**, principally the IVO Group itself. IVO International has benefitted from common problem solving with customers as well as from diffusion and direct transfer of technologies and information from customers. Foreign customers have not had any vital role in this development, as they have been very few and in mostly in less developed countries. The demand in energy field has not pushed IVO International to get involved in new technologies, as the customers are very conservative. More powerful

incentive to develop expertise in new areas have been the pressures to environmental protection since the 1980s.

Interaction with **manufacturers of equipment and machinery** was from the start very important contributor to IVO International's development of know-how and expertise in thermal power engineering. In addition to the intensive simultaneous interaction with customers and equipment suppliers during the assignments, the technological development was also always enhanced by regular interaction outside the actual projects. Moreover, the manufacturers constantly inform IVO International on their newest products and technologies. All interaction has included varying amount of diffusion and direct transfer of technologies and information from equipment manufacturers to IVO International. Today the development is reinforced through actual joint-research projects with both domestic and foreign manufacturers. Moreover, information on manufacturers' products is obtained for instance through IVO Group's acceptance test services.

IVO International considers the role of foreign suppliers for accumulation of its know-how and expertise to have been more significant than the role of domestic suppliers. Only in the 1990s domestic manufacturers are considered to be gaining the same importance in this sense as the foreign manufacturers. Exceptions are peat combustion technology and fluidized bed burning technology, where domestic equipment manufacturers have been more advanced. In general, IVO International considers its own contribution to the development of domestic manufacturers to have been more significant than their contribution to IVO's development of expertise. IVO has been a pioneer in the energy field, and simultaneously a progressive and demanding customer of domestic manufacturers of equipment and machinery.

The dependence on outside **research institutes and universities** in technological development is reduced by IVO International's own R&D activities and an easy access to the whole IVO Group's vast R&D resources. Moreover, the technology related to thermal power engineering is utmost conventional, which reduces the need for basic research. Nevertheless, from the technology diffusion point of view, interaction with both domestic and foreign research organizations has an important contribution to development of the company's know-how and expertise. Joint-research projects are essential to get acquainted particularly with new and progressive areas of thermal power engineering. Own R&D operations are considered to create an asset for exchange in cooperative joint-research projects.

The know-how and expertise in **environmental technology** has accumulated as a mixture of own R&D and interaction with domestic and foreign equipment manufacturers, and research organizations. To further develop its expertise IVO International aims at joint-research projects with domestic and foreign equipment manufacturers instead of pure purchase of equipment. Special attention is given to Japanese manufacturers, as Japan is the leading country of environmental technology. Joint research projects have been organized for instance with the VTT.

In addition to the technological development fostered by interaction, IVO International has benefitted from the large Group's internal organizational synergy. IVO also constantly organizes training and job rotation to enhance the expertise of staff. High educational background of the employees and proper recruitment are considered to form the basis for skilled personnel.

SUMMARY

IVO International's know-how and expertise is based on IVO Group's technical resources, know-how and experience in designing, constructing, operating and maintaining thermal power plants since the 1930s. IVO International has further developed its know-how and expertise in thermal power engineering through effective interaction with customers, foreign and later domestic equipment manufacturers, and research institutes and universities. The most important contributors have been foreign equipment manufacturers and the owner IVO Group as a loyal customer. The importance of contacts to research organizations has been overwhelmed by the important role of foreign manufacturers at the start, and later by own and IVO Group's R&D activities.

During the past ten years IVO International has established an informal contact network, through which the company continuously and efficiently gathers information in the field. Development of know-how and expertise is intensified through formal cooperation, joint research projects with manufacturers, research organizations and customers. Moreover, personal contacts to the network parties are considered important in gathering information.

5.2. CASE 2: EKONO ENERGY LTD

Ekono Energy Ltd forms part of Ener Group in Ekono Corporation. In 1991 the company's invoicing totalled FIM 52.4 million, of which domestic operations accounted for FIM 40 and foreign for FIM 12.4 million[102]. The number of employees was 130.

Products and operations of the whole Ener Group are organized under Ekono Energy Ltd. The company offers technology for production, transfer and distribution of various forms of energy based on coal, oil, gas, nuclear power and alternatives such as peat and biomass.

The focus of the case study will be on the part of the present Ekono Corporation that during its varying organizational history has been in response of the operations in energy field, and thereby possesses the know-how and expertise related to thermal power engineering. The name Ekono is used in the text to refer to the ETY Association since the 1950s, and the name Ekono Energy is used to refer to Ekono's energy related consulting and engineering operations since 1972.

DEVELOPMENT OF FIRM'S OPERATIONS

Ekono Energy's foundations were laid in 1911, when the Finnish Steam Boiler Owners' Association, the present ETY Association, was established. The Association's aim was to control the functioning and safety of its members' boiler installations by e.g. carrying out acceptance and condition monitoring tests. Most of the Finnish large industrial companies in various fields where then members of the Association. The Association financed its operations through member fees and payments for the inspection services. Consulting operations can thus be seen as commenced.

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[102]SKOL Laskutustilasto 1991, 2

In the 1920s and 1930s the Association had an important role in the electrification of industrial plants. It was active in consulting and engineering for back pressure power plants[103] and for steam boilers operated by industrial companies. Already then it can be considered to have formed an important advisory linkage between customers and manufacturers of boilers and turbines[104]. Wood processing industry became to a great extent independent of outside energy sources due to the efficient usage of back pressure power.

During the war years in the 1940s the name Ekono was attached to the Association and became commonly recognized both in Finland and abroad. During the same years Harald Frilund, a manager of Ekono, acted as a state power chief, which induced a great work load on Ekono[105]. Frilund had an important role in Ekono's development since the 1920s also in larger scope. Under his guidance the emphasis of operations changed from simple inspection services to engineering and consulting. He directed the operations to new fields along the technological development in the whole energy sector.[106]

The periods after the two Wars were both marked by a consequent strong recovery, development and growth in the Finnish industries. Particularly strong growth was manifested in wood processing industry. The active periods led to strong growth also in the Association's operations. Ekono started diversifying into other industrial sectors aside the energy field. During the 1950s back pressure power became increasingly convenient and important for wood processing industry[107]. Ekono contributed strongly to the increasing utilization of waste liquors for power production in wood processing industry, and to the augmenting growth and efficiency in back pressure power production[108]. In the 1960s the use of waste for power production in forest products industry for both economic and environmental reasons was further intensified.

In 1972 pure economic interests and those of the Association were separated: Ekono Oy and the Finnish Energy Economy ETY Association were founded. Ekono Oy, later Ekono Corporation, started selling consulting and engineering services backed with the know-how developed and accumulated through the operations of the Association during the decades.

In the end of the year 1911 the Association had 69 active member companies. In the end of the 1980s the ETY Association had over 300 member companies comprising all the large Finnish industrial companies, of which 75% in forest industries[109]. In 1992 the ETY Association still owned 70% of Ekono Corporation[110], but towards the end of the year industrial companies increased their share to 52%[111].

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[103]power station equipped with waste heat recovery for e.g. district heating, paper mill or other industrial purposes
[104]Hultin et al. 1961, 9
[105]Rouhiainen 1986, 3
[106]Hultin et al. 1961, 6
[107]Hultin 1961, 54
[108]Rouhiainen 1986, 3
[109]Hattari 1987, 707
[110]ETY Vuosikertomus 1991, 39
[111]Järnefelt 1993

NETWORK AND INTERACTION

The main actors within Ekono Energy's network are customers, manufacturers of equipment and machinery, competitors, and research institutes and universities. The state has always strongly influenced the Finnish energy sector determining the environment where the network is formed. Pressures towards the use and development of environmental technology have grown in the 1980s affecting the network environment.

Through the linkage to the Association Ekono Energy has always had a close connection to the large industrial companies in Finland, of which the majority in forest industries. Consequently, domestic **customers** have principally been industrial companies, members of the Association, and thereby owners of Ekono Energy. Interaction with domestic customers can therefore not be considered normal and objective buyer-supplier interaction. To maintain the close and mutually beneficial ties with the members, services were exchanged on preferential terms. As the linkage to the Association is becoming looser, the relationships with domestic customers is also changing. Today Ekono Energy's customers are not anymore solely members of the Association. By 1990s two thirds of the thermal power plants for the industry and district heating sector were designed by Ekono Energy. Interaction with both domestic and foreign customers is close and cooperative to guarantee the success of the assignment. At present foreign operations make up some 25% of the invoicing of Ekono Energy.

Relationship and interaction with domestic and foreign **manufacturers of equipment and machinery** is close and cooperative in on-going projects. In every project Ekono Energy faces different customers with different needs, for which the suitable solution with right machinery and equipment must be found. Therefore, simultaneous interaction with both equipment suppliers and customers must be intensive, collaborative and efficient to guarantee the optimal solution for the customer. Interaction with equipment manufacturers is frequent also outside the actual projects. At the beginning of the operations Ekono had to rely mainly on foreign manufacturers of equipment and machinery.

The main **competitor** in Finland is IVO International Ltd owned by IVO Group. The competition has intensified since the 1980s when IVO International formalized its consulting and engineering operations and refocused them on private sector.

Both domestic and foreign **research institutes and universities**, and the Germany based association in energy sector VGB (Technische Vereinigung der Grosskraftwerksbetreiber e.V.) form an important part of Ekono Energy's network. The relationship with the Technical Research Centre of Finland VTT and the Helsinki University of Technology TKK is rather close. The VGB's importance is rationalized by the fact that Germany has always been a leading country in the energy technology. The contact to it is coordinated through the ETY Association. Ekono Energy considers itself as an important linkage between scientific and business sectors, between basic research and industry.

DEVELOPMENT OF KNOW-HOW AND EXPERTISE

The Association was originally established to gather information related to thermal power engineering, to be able to serve the industrial companies in their need for control services. The very first know-how was acquired through recruitment of experts to work in the

Association. A major part of the technologies and information was acquired from abroad, especially from Germany, the leading country of energy technology. Due to the differing and usually more demanding conditions in Finland, new technologies had to be adapted to the Finnish conditions. This adaptation work demanded a great deal of expertise from the Association and forced it to go deeper into the technological know-how[112]. As the Association's scope of operations in the energy field widened, more know-how was demanded, and information was gathered more actively.

The growth and development of Finnish industries has contributed to the accumulation of Ekono Energy's know-how and expertise related to thermal power engineering. The economically active periods in the Finnish industrial history with growing demand for the Association's services forced it to learn by experience.

In the development of technological know-how and expertise through interaction the relationships with customers, equipment manufacturers and research organizations have been the most important. The nature of **customers**' operations were an impulse to Ekono Energy's technological development at the first place. Most of the customer industries demanded much energy for their processes, and the firms required efficient solutions for their energy need. This caused pressure on the Association and its know-how capacity and led e.g. to development of expertise in back pressure power production.

A particular effect on the development process had the wood processing industry, which grew the most vigorously and formed the largest and most powerful group among the customers. In addition to the advanced utilization of back pressure power, the strive for efficient utilization of waste liquors for power production in wood processing industries gained momentum particularly during the war years and shortage of fuel. Information on the waste liquor utilization was acquired to a large extent from Sweden[113].

New know-how and expertise emerge always as a result of efficient interaction in the assignments. Technologies and information also diffuse and are transferred directly from the customers to Ekono Energy, which continuously exploit their know-how base. Joint operations with customers create an opportunity to an even freer and more efficient flow of information.

Through the close and cooperative simultaneous interaction between Ekono Energy, customers and **manufacturers of equipment and machinery** there is a continuous diffusion and transfer of technologies and information enabling the development of know-how and expertise. In addition to the regular interaction outside the actual projects, both domestic and foreign manufacturers continuously inform Ekono Energy on their newest products and technologies for their own benefit and economic interests. More objective information on manufacturers' products Ekono Energy gathers through the test service in which it is engaged, including acceptance tests, condition monitoring tests, and maintenance and operations tests after installation. Ekono Energy has also occasionally enhanced its know-how and expertise through more formal interaction, joint-research projects with equipment manufacturers.

As Ekono Energy only conducts applied research interaction with **research institutes and universities** conducting basic research are utmost important for the technological

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[112]Buchert 1961, 39
[113]Buchert 1961, 44

development. The company follows closely the on-going basic research of various parties. As a linkage between basic research and industry, Ekono Energy creates suitable applications based on basic research for the use of industry, and simultaneously broadens its expertise benefitting from the flows of information in both directions.

In addition to the outside linkages Ekono Energy also benefits from the internal synergistic relationships and close interaction with the other business groups in Ekono Corporation, CTS Group serving forest products industry and Devecon Group active in construction and general process industries. For instance, detailed engineering of Ekono Energy's projects is usually carried out in cooperation with subsidiaries of Devecon Group.

SUMMARY

At the start of the operations the role of the ETY Association in the development of Ekono Energy's know-how and expertise was utmost important. Ekono leaned to a great extent on the collective pool of know-how and expertise with its background organizations, the Association's members. Still in the beginning of the 1980s the relationship between Ekono Energy and the Association was rather close in order to make maximum use of the complementary skills, knowledge and experience of Ekono and the member companies. Today the linkage to the Association is not very strong anymore, it is more of a formal nature. Closer cooperation to enhance the know-how and expertise is not reasonable as for instance IVO Group, owner of the competing TC firm, is also active in the Association.

Ekono Energy's present know-how and expertise related to thermal power engineering is also based on experience developed and accumulated through serving large industrial companies during the past 80 years. Information on new technologies has accumulated continuously through various linkages to different network parties, and the most efficiently through simultaneous interaction with mainly foreign manufacturers of equipment and machinery and the demanding customers, who pushed Ekono Energy to find new technologies and know-how to serve the members better.

Information on new scientific solutions has been gathered from research organizations conducting basic research. Important sources of new technologies have naturally also been domestic and foreign manufacturers of equipment and machinery. Following up of the manufacturers' technological development with or without joint projects is not considered difficult.

5.3. CASE 3: CTS EKONO

CTS Ekono is responsible for Ekono Corporation's consulting and engineering operations in forest products industry. In 1991 the company's turnover totalled FIM 210 million, and the number of employees was 700[114].

The main companies in CTS Ekono are CTS Consulting Ltd in Helsinki and CTS Engineering Companies Ltd in Kouvola. CTS Consulting provides services related to pre-investment studies and consulting, while CTS Engineering is in response of the engineering

[114]Ekono News 1/1992, 4

and detail design at the project implementation phase. CTS Consulting is the former forest products industry division of Ekono Corporation, CTS Engineering is former Teollisuussuunnittelu Oy acquired in 1987.

The focus of the case study will on the part of the present Ekono Corporation that during its varying organizational history has been in response of the forest products industry, thereby possessing the know-how and expertise related to pulp and paper industry. The case is primarily based on CTS Consulting Ltd, which is the successor of the original forest products industry division of Ekono and plays a dominant role in the present CTS Ekono. The name Ekono is used in the text to refer to the ETY Association since the 1950s, and the name CTS Ekono is used to refer to Ekono's forest products industry related operations since 1972. Development of the ETY Association's and Ekono's operations is presented in section 5.2 above.

DEVELOPMENT OF FIRM'S OPERATIONS

From the very beginning a major part of the ETY Association's members and customers were companies in forest products industry. To serve them efficiently, the Association was prompted to acquire a thorough understanding of the processes, raw material supply, management and economic systems of the clients in the industry.

Due to the strong recovery of forest products industry in the 1950s, many of the old member companies transformed into forest products companies in addition to the naturally increasing number of member companies in the industry. This pressured Ekono even more to get acquainted with wood processing industry and its technology.

In the 1950s Ekono can be considered to have implemented its first projects in forest products industry, design of evaporation plants for sulphite pulp mills. In the 1960s Ekono executed various projects related to pulp mills, and started also selling its know-how to foreign markets. Its expertise comprised know-how in pulping process and particularly in the energy saving related to it. This area of expertise became increasingly important in Finland in the 1960s and 1970s, and Ekono had an opportunity to realize several projects in the field. In the mid-70s Ekono started selling consulting and engineering for complete pulp mill projects.

In the 1980s Ekono Corporation further reinforced its operations in forest products industry. The share of projects in the field already represented more than a half of the Corporation's turnover[115]. In 1987 Teollisuussuunnittelu Oy, the present CTS Engineering, was acquired. The company principally serves paper industry. CTS Ekono's aim is to be able to provide the whole range of expertise in forest products industry, including both pulp and paper mill engineering.

NETWORK AND INTERACTION

The main actors within CTS Ekono's network are customers, manufacturers of equipment and machinery, competitors, and research institutes and universities. The network environment is affected by pressures to environmental protection.

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[115]Hattari 1987, 706

All domestic **customers** of Ekono's forest products division have always been members of the ETY Association, which served CTS Ekono as a route for contacts and interaction with the large industrial companies in the wood processing industry. In the early 1950s the members pressured Ekono to get ever more involved in technology and know-how related to wood processing, as they needed consulting in this new and growing field. At that time Ekono still was the only consulting firm in the field. Domestic customers, simultaneously members of the Association, can thus be seen as an impulse for Ekono's operations in forest products industry.

Due to the preferential buyer-supplier relationship during the 1960s interaction cannot be considered unbiased. The relationship was naturally closer and more confident than in normal business. In the 1970s the buyer-supplier relationship became more objective, as the importance of the ETY Association's role decreased. In general, CTS Ekono considers close, constructive and confident personal contacts and interaction with customers utmost important to be able to serve them efficiently.

Success on the foreign markets proves the true competitiveness of Ekono's operations in forest products industry. Foreign customers have been served already since the 1960s. Operations were internationalized to a much larger extent than in the energy division. Today the share of foreign invoicing in both main companies of CTS Ekono is around 80%.

CTS Ekono aims at efficient interaction with domestic and foreign **manufacturers of equipment and machinery**. Sometimes interaction is competitive as manufacturers temporarily tend to step into TC firms' business and vice versa.

CTS Ekono interacts simultaneously both with equipment manufacturers and their common customers, producers of pulp and paper. Particularly in on-going projects the interaction among these three parties is very close in order to find the right solution for the customer. CTS Ekono considers itself to form a linkage for communication between manufacturers and pulp and paper producers. Interaction with equipment manufacturers is regular also outside the actual projects.

The main **competitor** in Finland is Jaakko Pöyry Group.

Interaction is very close and cooperative with a **research institute** Oy Keskuslaboratorio Ab KCL owned by the Finnish pulp and paper producers, that is, the same companies that principally own Ekono Corporation. Common owners of the both organizations, simultaneously being customers of the both, creates a sound basis for close and continuous cooperation. With the Helsinki **University** of Technology TKK the interaction is more formal and objective.

DEVELOPMENT OF KNOW-HOW AND EXPERTISE

At the beginning of forest industry related operations the basic know-how and expertise, particularly the experience in processes and operations, was largely drawn from Ekono's background organizations. Experts with experience in production were employed into Ekono's new division from member companies. Later on new employees also came from the KCL and equipment manufacturers. Today recruitment of young graduate students is important to gain expertise in modern information technology.

During the first decades of operations strong growth of the industry generated many projects for Ekono's forest products division, and pushed it to accumulate its know-how and expertise through experience. Along the wood processing industry's numerous energy saving projects of the 1960s and 1970s Ekono had an opportunity to further develop its expertise in pulping processes. The company has also had true innovators, who have actually created new know-how and new expertise, technological innovations.

In the development of technological know-how and expertise through interaction the relationships with customers, equipment manufacturers and research organizations have been the most important. Facing different **customers** with different needs in varying situations forces CTS Ekono to continuously develop its know-how and expertise through interactive learning. During the assignments simultaneous interaction with customers and **equipment manufacturers** must be open and cooperative to guarantee the achievement of optimal solution for the customer. Information flows freely among the three parties enabling CTS Ekono to easily accumulate its know-how through diffusion and direct transfer of technologies and information. In general, domestic customers are considered to have had a more significant impact on CTS Ekono's technological development than foreign customers.

Also outside the actual projects CTS Ekono gains plenty of know-how related to equipment and machinery directly from the manufacturers, who for their own benefit and economic interest actively inform CTS Ekono on their newest products and technologies. Simultaneously CTS Ekono informs them on their common customers', pulp and paper producers' needs. CTS Ekono must keep in pace with the technological development of both the equipment manufacturers and producers of pulp and paper. Its principal task is to improve the customer's system of processes and production by combining the equipment and machinery of different manufacturers in the right way. The company considers the technological know-how and expertise related to the processes and production more important than know-how and expertise related to the equipment and machinery. CTS Ekono considers itself to have benefitted technologically more from domestic equipment manufacturers than from foreign manufacturers.

As CTS Ekono only conducts applied research, relationships and interaction with **research institutes and universities** conducting basic research is essential. An extremely close and synergistic relationship with the KCL is very important for CTS Ekono's development of know-how and expertise. The two organizations have a clear division of work the KCL conducting basic and CTS Ekono applied research, and the exchange of information is effective. The company gains results of the KCL's basic research in a preferential order. The role of independent and objective Helsinki University of Technology is less important but not to be undervalued.

To keep in pace with the development of **environmental technology** CTS Ekono considers more important to enhance the understanding of decision makers and those who demand for it, than of the actual technological know-how. In order to expand the knowledge in environmental technology CTS Ekono has established cooperative relationships with the Technical Research Centre of Finland VTT, the Finnish Pulp and Paper Research Institute and Finnish and foreign technical universities. Moreover, a foreign company possessing expertise in recycled mass technology will be acquired in 1993.

CTS Ekono also benefits from the close and synergistic relationships and interaction among the separate companies within it. The contribution of the acquired CTS Engineering was obvious to the paper industry related know-how. CTS Ekono also benefits from synergistic relationships with other business groups in the Corporation, Ener Group and Devecon Group operating in the complementary fields. The Ener Group was originally the basis for Ekono's operations and expertise in the forest industry.

SUMMARY

The significance of the ETY Association itself has been far less important for CTS Ekono's technological development than what it has been in Ekono Energy, as the Association's activities are principally related to the energy field. The company's know-how and expertise rather originates from Ekono's member companies in wood processing industry, who also were an impulse to the start of operations in the 1950s. Since then the know-how and expertise has developed and accumulated through experience along the efficient interaction in the assignments, and other interaction with customers, equipment manufacturers and research organizations. CTS Ekono benefits from interaction with all parties, especially from interaction with the customers, in the particularly advanced and developed Finnish forest products industry.

5.4. CASE 4: JAAKKO PÖYRY GROUP

Jaakko Pöyry Group provides consulting and engineering services principally in forest products industry. In 1991 the company's invoicing totalled FIM 261 million, of which domestic invoicing accounted for FIM 114.9 million and foreign for FIM 146.2 million[116]. The number of employees in 1991 was 5500, of whom 1600 worked in Finland. The company has a wide global organization.

The focus of the case study will be on the organizational unit or units which possess the know-how and expertise related to pulp and paper industry.

DEVELOPMENT OF FIRM'S OPERATIONS

Jaakko Pöyry Group was established in 1958 by Mr Pöyry and Mr Murto, two engineers specialized in forest products industry. As an impulse to the start of consulting and engineering operations was customers' demand. Already the first project was a result of an initiative of a customer demanding basic engineering for a new pulp mill. The 1950s being a decade of strong recovery and large investments in forest products industry guaranteed a growing demand for Pöyry's services from the start. The producers of pulp and paper started demanding TC firms' services as the investments had become too large for them to master alone.

Since the first project in 1958 Jaakko Pöyry has completed around 5000 projects for some 500 customers in 100 countries[117]. Over 250 of them have been large pulp and paper mill projects. Operations and organization have been internationalized rather fast.

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[116] SKOL Laskutustilasto 1991, 2
[117] Korpivaara 1989, 10

During its existence Pöyry has diversified into various sectors of industries and services. However, consulting and engineering in forest products industry still remain the main area of operations, pulp and paper industry being the most important customer. In 1991 Pöyry's pulp and paper related work accounted for about 65% of total engineering work input[118].

NETWORK AND INTERACTION

The main actors within Jaakko Pöyry Group's network are customers, manufacturers of equipment and machinery, competitors, and research institutes and universities. The network environment is affected by pressures to environmental protection.

The initial contacts to domestic **customers** were already established in the 1950s during Mr Pöyry's post in Wärtsilä. The first foreign customers, the Swedish, were served at the early 1960s. Through the Swedish customers and their investments abroad contacts were soon established also to other foreign customers. Today Pöyry has several regular customers on both domestic and foreign markets.

Pöyry considers close and cooperative relationship with customers an elementary basis for every project. Intensive and open interaction is considered to generate progressive design improvements until the ideal solution for a customer is achieved. Sometimes Pöyry suggests the client a joint research program for the basis of the investment project. Consequently, interaction with customers is very close and flow of information is free.

Stemming from his earlier work experience Mr Pöyry has always had close contacts to the domestic **manufacturers of equipment and machinery**. They supply the equipment and machinery in close and cooperative simultaneous interaction with Pöyry and the customer to guarantee the optimal solution for the customer. Occasionally manufacturers themselves are customers of Pöyry, when they need Pöyry's consulting services.

Pöyry contacts regularly both domestic and foreign manufacturers. Interaction is keen and open. Pöyry considers itself to be a linkage between pulp and paper producers and equipment manufacturers in the field.

The main **competitor** on the domestic market is CTS Ekono.

Pöyry interacts both with **research institutes and universities**. Cooperation has been close for instance with the Graphic Laboratory of the Technical Research Centre of Finland VTT. A close contact to the Helsinki University of Technology has been natural as Mr Murto was initially a professor at the University. Moreover, Mr Pöyry has continuously had close personal contacts with several university professors in the field.

DEVELOPMENT OF KNOW-HOW AND EXPERTISE

The basic know-how and expertise originally came along to the company with its founders. Mr Pöyry was earlier employed by a manufacturer of equipment and machinery for forest products industry. He had experience in project implementation in practice. Mr Murto had

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[118] Jaakko Pöyry Group Report 1991, 13

gained experience in project work in Metex, and technological expertise related to the field at his work at the Helsinki University of Technology. Both founders were specialized in their own and complementary areas of expertise.

In addition to know-how and expertise, the founders brought along contacts to forest products industry: Mr Pöyry to pulp and paper producers and equipment manufacturers in the field, and Mr Murto to the universities. In particular Mr Pöyry's personal contacts to the field had an important contribution to the development and know-how in the company. He knew how to productively exploit the relationships both with the business and research fields. Close personal contact network for accumulation and compiling of know-how was wide from the beginning. It included customers, equipment manufacturers and universities.

At the start of the operations in the 1950s strong recovery and investments in the industry generated much work for Pöyry, and consequently gave an opportunity for efficient learning by experience. Moreover, at the early and growth-oriented years expertise was obtained through recruitment. New employees came often from producers of pulp and paper with the respective know-how in production and processes. Later experts were hired into the company also solely to increase the know-how in some particular new area.

Pöyry maintains and develops its know-how base by continuously following both the market forces and technological development in the field. Keeping in pace with the technological development was enhanced in the 1960s, when a separate unit was established to follow the development in the field. This unit also served equipment manufacturers in their need for outside consulting and engineering. Closer interaction with equipment manufacturers was hence stimulated, and opportunities for diffusion and transfer of information and technologies, and accumulation and development of know-how, increased.

In the development of technological know-how and expertise through interaction the relationships with customers, equipment manufacturers and research organizations have been the most important. The **customers** have been demanding from the beginning, and have pushed Pöyry project by project to develop further its expertise. Projects are executed in cooperation with both the customer and **equipment manufacturer**, as close simultaneous interaction guarantees the success of the project. Interaction with both domestic and foreign customers and equipment manufacturers has always been close and cooperative, and the flow of information free. This, in addition to the actual joint-research projects with customers and other regular interaction with equipment manufacturers, has led to diffusion and transfer of information and technologies, and consequently enabled Pöyry efficiently to accumulate its know-how. Moreover, both domestic and foreign equipment manufacturers actively provide Pöyry with information on their newest products and technologies.

Close relationship and interaction with **research institutes and universities** also foster the technological development. As Pöyry itself conducts only applied research, interaction with network parties involved in basic research is important.

Pöyry considers interaction with customers, equipment manufacturers and research organizations important also when enhancing the know-how in **environmental technology**. For instance in technology for air pollution control the company has learned much from the Finnish equipment manufacturers, whose level of expertise in the field is high.

Pöyry's technological development also benefits from the organization's internal synergy. A large global and diversified organization provides ideas and design experience from sectors other than forest products industry, and the local offices continuously expand the company's know-how base. From this point of view Jaakko Pöyry's slogan "Global resources - local presence" can be also interpreted in "Global know-how - local applications". Pöyry's research activities occasionally provide the company with entirely new know-how and expertise, more radical innovations. The company organizes also internal training and job rotation to raise the level of expertise of its employees.

SUMMARY

The origins of Jaakko Pöyry Group's know-how and expertise are found in the founders of the company. In further technological development learning by doing induced by numerous investment projects in forest products industry during the first decades had an important role. Close and cooperative interaction with demanding and sophisticated customers and equipment manufacturers in the projects and also outside the actual projects has been an essential contributor in the development process. Contacts to research institutes and universities have also contributed to the development of know-how and expertise.

Today Pöyry considers close relationship and interaction with the Finnish forest products industry, producers of pulp and paper and manufacturers of equipment and machinery, the most important way to maintain and develop its know-how and expertise.

5.5. CASE SUMMARY

In all case firms network interaction, learning by experience and internal factors were found to contribute to the development of technological know-how and expertise. The most important interactive relationships contributing to the development were those with customers, equipment manufacturers and research organizations. Interaction was typically close and cooperative in projects with customers and equipment manufacturers forming a fruitful basis for enhancement of technological development by both experience and interaction. Interaction contributed to development process by providing a channel for technology diffusion and transfer, and enabling common problem solving, interactive learning and thereby development of new know-how and expertise. Interaction was also regular outside the projects with equipment manufacturers and research organizations. The dependence of the case firms on outside linkages to enhance technological development was reduced if strong internal organizational synergy and own research activities were to be found.

Interactive development process of know-how and expertise in the case firms was facilitated by two factors. Firstly, due to the smallness of the Finnish economy both the energy sector and forest products industry are small and number of actors limited, which makes the diffusion of information and technologies fast and efficient. Secondly, both thermal power production and pulp and paper production related technologies are considered conservative and conventional. Development process of technologies is gradual and slow, and therefore easy to follow. Conservativeness also reduces the importance of basic research lacking in most case firms.

Importance of wide network of manufacturers in the enhancement of technological development through interaction is emphasized by the fact that the case firms' expertise is based on various technological areas and they consequently need contacts to several manufacturers to keep in pace with technological development.

For IVO International interaction with outside parties to enhance technological development was less important than for other case firms due to IVO's own vast research and other resources and organizational synergy. IVO International was also able to conduct more intense cooperation with outside research institutes as IVO's own research activities created an asset for mutual exchange of resources, where both parties derived benefit from interaction. Positive effects of network interaction in energy sector was to some extent reduced by the lack of advanced domestic manufacturers.

Competitive, strong and well developed domestic forest products industry has provided an excellent support for technological development through interaction for both CTS Ekono and Pöyry. They have benefitted from interaction with demanding and advanced domestic customers and equipment manufacturers, and with the numerous research organizations engaged in research in the field. CTS Ekono's relationships and interaction with actors in the industry have been particularly cooperative because of the company's ownership structure. Various joint-research programs organized in cooperation with all actors in forest products industry to enhance the overall know-how and expertise in the field were prominent. The synergistic link between energy sector and forest products industry has been efficiently exploited by Ekono Corporation.

6. CONCLUSIONS

TC firms develop their technological know-how and expertise through experience and network interaction. Other ways to accumulate technological capabilities are firm acquisitions, recruitment, internal training and synergy conferred by large and diversified organization. Development of know-how and expertise in TC firms is technological development based on continuous and incremental technological innovations.

The most important network parties fostering the development are customers, manufacturers of equipment and machinery and research organizations. Innovations in technological development through interaction result from imitation enabled by diffusion and transfer of technologies, and from inventing, a result of common problem solving and interactive learning process together with customer and equipment supplier in projects. Learning by experience is actually based on interaction with customers and equipment suppliers during the assignments. The concept network interaction covers also interaction outside the actual projects.

Interaction varies from passive interaction such as occasional exchange of resources to more active such as joint-research projects. The more active interaction is, the more parties generally benefit from it in respect to the technological development. Relationship and interaction with TC firms typically is active, close and cooperative in the assignments, as free flow of information among the customer, TC firm and equipment supplier is a prerequisite for a success of the project. Outside the projects interaction with customers and equipment manufacturers is more passive but regular.

TC firms interact actively also with research institutes and universities to accumulate their know-how. As TC firms mainly conduct applied research, interaction with those conducting basic research is essential. Own R&D activities reduce the dependence on outside research organizations.

TC firms' technological development can ultimately be seen to depend to a great extent on external factors such as the level of basic research, equipment manufacturers' product development work and customers' needs. TC firms concentrate on innovatively adjusting themselves to the changing situations caused by technological development in the field, and on being able to develop a functioning system of available technologies suitable for customers' needs.

The case studies support the theoretical suggestions and view of interactive development process of technological expertise in TC firms. They also show that the need for interaction to promote know-how and expertise vary according to TC firm's background and field of operations. In general, dependence on outside linkages to enhance technological development is reduced by strong internal organizational synergy and own research and other resources. Well developed field of operations with many diversified actors creates opportunities for efficient accumulation of know-how and expertise through interaction.

7. SUMMARY

The aim of the study was to describe and evaluate the effects of network interaction on development of technological know-how and expertise in technical consultancy (TC) firms. The process and mechanisms of the progress was explored.

The study consists of theoretical and empirical parts. Theoretical part provided the framework and concepts for evaluation of the phenomenon in focus. Theories related to industrial networks, interaction, innovations and industrial services were presented, and a model was developed to describe TC firm's technological development through network interaction. Selection of interaction and network approaches for the basis of the study is supported by the interactive nature of TC firm's operations. There are earlier studies basing on network approach which focus on TC firms (Sharma 1989, 1991) and technological development in industrial manufacturing firms (e.g. Håkansson 1987, Laage-Hellman 1987).

The empirical part of the study consists of four cases describing the development of technological know-how and expertise in Finnish TC firms operating in energy sector and forest industries. The model developed in the theoretical part was applied to the case firms. The results of the empirical part support the theoretical suggestions and view of interactive development process of technological know-how and expertise in TC firms.

The main actors in all case firms' networks contributing to interactive technological development were customers, equipment suppliers and research organizations. Development of technological know-how and expertise in TC firms is technological development based on incremental technological innovations. Innovations are a result of original inventing and imitating. Incremental innovations are principally small improvements on innovations imitated from others or an outcome of interactive learning, both enabled by interaction between organizations. TC firms accumulate their technological know-how and expertise through learning by experience, imitating and interactive learning. They do not usually conduct basic research, but rather concentrate on applied research. Learning by experience can also be seen as interactive learning, and imitating can be seen as diffusion of information and technologies.

Interactive learning and diffusion take place when TC firms implement projects and in interaction outside the actual projects. Interaction during assignments is very cooperative and active with customers and equipment suppliers. Aside the projects TC firms interact regularly with equipment suppliers and research organizations. Dependence of TC firms on outside linkages to enhance technological development is reduced if strong internal organizational synergy, and own research and other resources are found. Ability to promote know-how and expertise through interaction also depends on TC firm's background and field of operations. Well developed field of operations with many diversified actors creates opportunities for efficient accumulation of know-how and expertise through interaction.

Interactive development process of technological know-how and expertise in the four case firms was facilitated by two factors. Firstly, due to the smallness of the Finnish economy both the energy sector and forest products industry are small and number of actors limited, which makes the diffusion of information and technologies fast and efficient. Secondly, both thermal power production and pulp and paper production related technologies are considered conservative and conventional. Development process of technologies is gradual and slow,

and therefore easy to follow. Conservativeness also reduces the importance of basic research lacking in most case firms.

Importance of wide network of manufacturers in the enhancement of technological development through interaction is emphasized by the fact that the case firms' expertise is based on various technological areas and they consequently need contacts to several manufacturers to keep in pace with technological development.

TC firms' technological development can ultimately be seen to depend to a great extent on external factors such as the level of basic research, equipment manufacturers' product development work and customers' needs. TC firms concentrate on innovatively adjusting themselves to the changing situations caused by technological development in the field, and on being able to develop a functioning system of available technologies suitable for customers' needs. Successful innovative adjustment to technological changes caused by external factors in enabled by effective interaction with research organizations, equipment suppliers and customers.

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Appendix

STRUCTURE OF FIRM INTERVIEWS

How have the firm's operations developed since the start?

What were the impulses leading to first assignments?
Who was the first customer?
Who supplied the equipment?

How was technological know-how and expertise acquired for the first assignments?

What was the role of customers, equipment manufacturers, research organizations or any other named party in obtaining the know-how for first assignments?
What were relationships and interaction like with the above parties?

What was the role of earlier experience, sister/parent companies or any other named factor in obtaining the know-how for first assignments?

Describe the technological development in the field after the start of operations. How did the firm adapt to the development with its own development of technological know-how and expertise?

What was the role of customers, equipment manufacturers, research organizations or any other named party in obtaining the know-how along the technological development in the field?
What were relationships and interaction like with the above parties?

What was the role of earlier experience, sister/parent companies or any other named factor in obtaining the know-how along the technological development in the field?

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