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Industrial Growth and Development in Northern Finland: The Case of Oulu 1970 – 2002

Hyry, M.

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Martti Hyry

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Coventry University

Executive Summary

This thesis explores the reason why the region of Northern Ostrobothnia and in particular the city of Oulu became known as the High Tech capital of the Nordic countries during the 1980s and 1990s. After World War II, the region's economy was dependent upon its traditional industries of forestry, wood processing, pulp and paper manufacturing and to a lesser degree on iron and steel manufacture. In common with other parts of Northern Finland, Northern Ostrobothnia suffered from high unemployment, low educational standards, outwards migration and below average standards of living and life expectancy.

Aware of these problems, the national government in Helsinki embarked on a series of measures to improve this situation. First and foremost, a university was established in Oulu and its first three faculties were teacher training, medicine and engineering. The university was charged with the specific tasks of educating and conducting research to benefit the economy of Northern Finland. It was realised that economic changes were essential and attempts were made to build an electronics industry in the region to make it less dependent on natural resources. To facilitate economic developments, infrastructural improvements were made and branches of VTT and Tekes were established in Oulu. A key factor here was the government realisation that decision-making for improvements in the region should and would be devolved to the local authorities. That was the opportunity for the city of Oulu to seize initiative, and in concert with the University and a group of local entrepreneurs, to set up a Technology Park, Technopolis, in 1982 at Linnanmaa beside both the university and VTT. These small beginnings provided the foundations for sectors such as electronics, computer software, telecommunications and biotechnology sectors to emerge gradually, so that by the year 2000 there were nearly 12,000 high tech jobs in the area.

A crucial addition to this development in the long term was the arrival of Nokia to Oulu. At first Nokia concentrated on cable technology and base stations, but once it diversified into telecommunications and built up partnerships with local firms a clearly-defined high tech cluster became visible. Within the cluster, there is significant cooperation between the relevant New Technology Based Firms (NTBFs), Nokia and the local educational and research establishments. The outcome, at the time of writing, is that Oulu has gained a world reputation as an innovative centre of high technology, and it is the circumstances behind this reputation that the remainder of this thesis seeks to investigate.

Preface

This study was carried out jointly between Coventry University and the University of Oulu. The study was carried out at the Learning and Research Services of the University of Oulu for the Coventry Business School.

I would like to express my deepest gratitude firstly to the Dean of the Coventry Business School, Professor David Morris, for enabling this whole process to take place, and secondly to Dr. Tom Donnelly, the Director of Studies there. Tom encouraged and guided me throughout this work and over the various hurdles with great expertise, admirable fortitude and good humour. In this respect, I also wish to thank my supervisors Mr Clive Collis, Dr Helen Lawton Smith and Professor Pekka Kess for their constructive advice during the different stages of the work.

My thanks to all the interviewees for their first hand knowledge and providing the material for my work, without which my work would have been incomplete. I also thank the staff at Nokia, and other organisations, for assisting me in finding the right people, and making time to provide the material for my work and answer my questions.

Many other people have greatly contributed to my work. Ms. Anna-Mari Osma patiently helped me analyse and understand the Oulu Business Review database and transform its figures into data and tables. To Dr. Petri Ahokangas, Mr. Ilkka Marjomaa, Mr Pekka Räsänen and Prof. Harri Haapasalo a big thank you for our ongoing discussions during my work and for assistance as collaborating authors of various articles. I am also grateful to the Ahti Pekkala Fund for its support in the early stages.

This study has taken almost a decade. Wading through the tasks of analysis and writing, it sometimes seemed to be an endless project, whereas other times a flash of progress spurred me on. The process of writing is like wrestling with an invisible opponent, but in the end, what was needed was guts, or “sisu” as we say in Finnish. Needless to say, working in English made it all the more of an uphill struggle. Thanks to Hilary Keller for her help in language matters.

After spending many hours, evenings, days, weekends, weeks and months alone in the research chamber in long discussions with my computer, I especially wish to express my gratitude to my family, my lovely wife Anja, children Ville and Laura and all my friends for their ongoing support.
This thesis is dedicated to my deceased parents, my father was the one who appreciated the technology of his time and my mother appreciated the beauty of education.

Valkiaisjärvi, September, 2004
Martti Hyry

CONTENTS

1 Introduction

In the last three decades, high technology firms and the clusters of such firms have come to play an important role in creating employment and welfare in the developed countries. The terms "new technology or high technology" are time-bound. A wider definition can be found in the term "advances in technology" (Drucker 1985). The origin of this definition appeared at the end of the 1600s and was accepted until World War II, when "advances in technology" were related to the traditional industries of coal, iron steel, shipbuilding and textiles and were also associated with increasing speed, higher production and productivity levels. After World War II, the industrial structures and processes diversified into newer sectors such as the automotive, aviation and biological and biochemical industries.

In this study, and more generally in line with current thinking, new technology today refers principally to the development paths or processes arising from electronics, or semiconductor technology from which modern computers, software, the telecommunications and biotechnology industries have all evolved.

This study examines the industrial development in the Oulu Region, also known as Northern Ostrobothnia, in Finland between 1970 and 2002. The Oulu Region has become one of the leading centres of the new technology-based industries in Finland, and often referred to as 'the Oulu Phenomenon' or as 'the Miracle of Oulu'. There were no regional traditions favouring this type of development in Oulu, but the Oulu Region has similarities with other corresponding development paths in the UK (i.e. in Cambridge and Scotland).

The rise of the electronics industry based on the new semiconductor technology led to new innovative products and industries both nationally and globally. This kind of development started after World War II in the U.S. in areas such as Silicon Valley, Route 128 and San Antonio, where the first technology-oriented clusters of firms were set up around the new technology based industries. Although the role of the electronics industry as a provider of new jobs rose sharply in the USA in the 1960s, the changes were not very dramatic. Between 1960 and 1985, the new jobs in the electronics industries barely replaced those which had been lost in the older traditional industries such as coal, iron, steel, shipbuilding and textiles (Drucker 1985). Furthermore, the new jobs were concentrated primarily in new industrial areas of the

western states such as in California, whereas the older industrial districts tended to be located in the east of the country.

Later on in the 1970s, similar developments took place in Europe. In the UK new clusters emerged near research institutes and universities, as in the case of the Cambridge Research Park (1972), or based near the dense concentrations of government scientific bodies, parallel to the M4 motorway, especially close to the Reading- Newbury- Oxford triangle. On the other hand, in France the roles of the national government and of the local authorities were key. A good example was the establishment of Sophia Antipolis near Nice. In fact, Cambridge and Sophia Antipolis are now considered the European pioneers of the new technology-based industry. The concept of science parks has gained in strength and several parks, such as Warwick in the UK, are evidently following these early pioneers and have been set up close to universities and/or research institutes.

Finland was not in the frontline of this development, but the Oulu Region was an exception. However, before proceeding to discuss the situation in Oulu, it would be helpful to outline the changes that took place in the national economy so that the Oulu experience can be analysed subsequenly against a broader canvas.

1.1 The Finnish Economy

By the time Finland gained its independence from Russia in 1917, its national income and income per capita compared relatively favourably with those of other parts of Western and Northern Europe. During the remainder of the twentieth century, Finland's total per capita income grew more than eleven fold or at an average rate of three per cent annually which was faster than any other country. By the late 1980s, with its population of five million people, Finland exceeded the average income level for developed industrialised nations within the OECD. Although the early 1990s were years of severe recession, since then economic growth has been rapid and, by 2000, Finland had exceeded not only the average per capita income levels in the OECD, but also that of its near neighbour, Sweden (Loikkanen et al, 1997; Finnfacts, 2004).

Finland's growth from the mid nineteenth century was a result of on the dramatic rise of the sawmill industry, and then of the paper industry. That was preceeded by exports of tar, charcoal in exchange for iron works and sawn wood. Nearly all the machinery, equipment and technology was imported, In other words, the early pattern of development was from tar to wooden planks and to paper. Although paper still remains importan to Oulu, many other sectors such as the paper making machinery have sprung from it. Today Finland is a world leader in paper making technology. Further developments linked to the forest industries have been in the fields of chemicals, electronic and automated systems involved in forest-industry management processes. Forestry has become a highly knowledge intensive industry, although still based on raw materials, (Loikkanen et al, 1997; Hernesniemi et al, 1994; Finnfacts, 2004).

In addition to agriculturally based products, Finland has also developed an extensive metal and mechanical engineering industry. At first, growth was based on raw materials whereas the machinery and technology were imported, but over time imports were replaced by domestically produced products, which were subsequently exported, often as very high technology variants. At the time of writing, most of Finland's mineral deposits are near exhaustion, but the country still retains a highly developed expertise in machine and equipment design associated with electronic and computer driven systems which reflect the strides the country has made more generally in information and communications technologies. In the latter, the country ranks among world industry leaders as Finland edges its way in the direction of the new digital economy (Finnfacts, 2004).

As Finland's industrial structure has changed, so too has its corporate structure. Most of Finland's major corporations were formed in the latter half of the nineteenth or early twentieth centuries with the top thirty firms being more than a hundred years old. Few however have remained in their original sectors, or even their original locations. Change has come about through acquisition, mergers, the creation of new fields and usual industrial diversification to take advange of new technologies, products, income levels and new markets. Much of the country's early industrial growth was due to foreign trade, but a considerable amount was also caused by small firms such as forest owners moving into other areas such as sawmills, wood suppliers, brick work, chemicals and paper manufacturing, for example. This type of process gave rise to multi-conglomerate structures (Finnfacts, 2004).

The recession of the 1990s ended this type of growth. Amid a wave of mergers, companies tended to specialise increasingly on what they considered their core business. There was a considerable amount of fragmentation of structures that had been put together in the 1960s and 1970s. For instance, by the middle of the 1990s the paper industry had consolidated and was in the control of three large concerns, UPM-Kymmene, Stora Enso and Metsäliitto, all of whom have since become major multinationals in their fields. Similar consolidation has taken place in the banking and finance sectors. In contrast to the situation in forestry, the textile industry has all but disappeared, its place has been taken by the rise of the electronics and ICT industries which have grown rapidly over the past two decades. Output in electronics rose seven fold in the 1990s due to the increase of exports in telecommunication equipment. In this field, Nokia has become Finland's most important company, accounting for four per cent of the national GDP and 30 per cent of the total of all Finnish exports, compared to the paper industry's 25 per cent. Obviously, Finnish exports are heavily biased towards two main sectors which is both a strength and a weakness. Global trade in forest products is subject to wide fluctuations in both price and volume. In the past when Finnish products slumped in the market, the government had recourse to currency devaluation, but since adopting the Euro as the main currency, this option is ruled out. As regards the telecommunications industry, few problems have arisen so far, but there is a feeling that in the light of intense competition in these and related industries, Finnish companies will only survive in the long term if they continue to exhibit a high rate of product innovation (Finnfacts, 2004).

Until the 1990s Finland was an extremely nationalistic nation. Governmental attitudes to inward foreign direct investment (FDI) was one of wariness and strict laws concerning the role of FDI in the economy were enforced. The latter, however, had to be relaxed in 1993 when Finland joined the European Economic Area, which also led to the deregulation of capital movement. During the 1990s, inward FDI increased as the economy became more open and foreign investment took place in transport and in the industrial and service sectors. For instance, ABB is now one of the largest foreign firms in Finland, ranking among the first five industrial employers. Indeed, by 1999 the number of foreign owned firms operating in Finland exceeded one hundred and fifty and often these have been motivated by a desire to acquire Finnish industrial know-how (Finnfacts, 2004).

In consequence of the developments made in recent decades, Finland has specialised in competing in the High Technology sector in global markets, particularly in information and

communications technology. Finland's exports in this field means that the country's high tech foreign trade surplus is greater than that of any other EU country, except the Republic of Ireland. In other words, in these areas Finland is one of the world's most competitive nations. This is due mainly to the high level of education and the fact the country is one of the highest users of new technologies, both of which add to an overall high level of awareness of new technology and a willingness to accept it in daily life. Nevertheless, Finland cannot afford complacency, it has a small population and consequently a small domestic market, it is geographically remote from the world's industrial heartlands and also suffers from high rates of taxation and an unemployment rate of circa ten per cent at the time of writing (Finnfacts, 2004).

If future competitiveness is to be maintained then there must be continuous adaptation to ensure the ability of the ICT and related industries to surive in various fields. Because of its size Finland cannot compete with the United States, for example, in the broad range of ICT, and so perhaps would be well advised to persevere in product and process specialisation through networking between companies both at home and internationally if progress and development are to continue (Finnfacts, 2004).

1.2 Oulu and Northern Finland

In the late 1960s and early 1970s, ideas were discussed both locally and nationally about the possibilities of attracting the new electronics industry to the Oulu Region and Northern Finland. The initiators of these new ideas were two professors in the University of Oulu, Juhani Oksman and Matti Otala. The initial progress was slow with only two new firms emerging in electronics. The first of these was Kajaani Oy which was formed in Kajaani, a town some two hundred kilometres south east of Oulu, in 1969 and the second was Nokia's move into electronics when it came to Oulu in 1972 (Oksman, 2002; Jakkula et al, 1983).

A decade later in 1982, a technology park was established in Oulu, the first one in Scandinavia. Inspiration is said to have come from Scotland's apparent success in attracting incoming investments in the electronics industry to offset the decline of its Central Belt of iron, steel, coal and shipbuilding industries (Oksman, 2002; Similä, 2002). A further example, of course, was Silicon Valley, which encouraged people in the Oulu Region to become more proactive. After a slow start in the 1980s, the technology-based industry and the Technology Park began to

expand very quickly. By the end of the 1990s the city of Oulu had changed from being a typical Finnish city in the 1970s, i.e. one with an economy based on local resources, into a good example of a technology-based centre, which became a model for other regions in Finland and elsewhere. The industrialising process in Oulu has now more than 30 years experience, just as Cambridge and Sophia Antipolis do, although the Technology Park in Oulu itself is much younger. In all of these European pioneer centres of technology, the starting points have been different, as have their respective development patterns. Only now, after thirty years, has it become possible to examine the whole development experience and to evaluate the case of Oulu so as to see what can be learned from it.

At the time of writing, it is clear that Finland has gone through a massive structural industrial change in the recent decades. In the 1990s, imports of high-technology products were high (i.e. imports of roughly 2 billion euro, exports of 1 billion euro), whereas in 2000 imports stood at approximately 7 billion Euro and exports at 11.5 billion euro. The growth in exports was a direct result of the growth in the high- technology based industries (Statistics Finland, 2002).

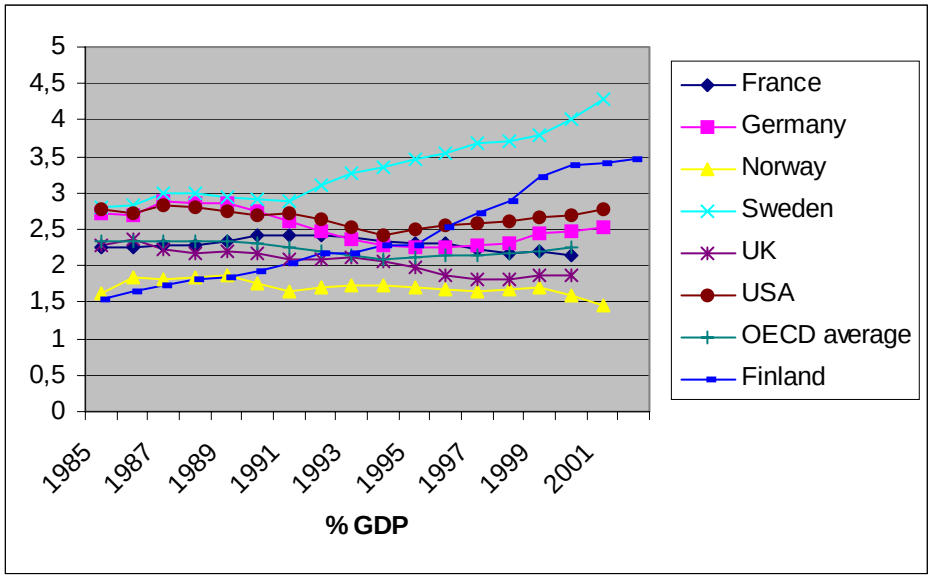
The question we must ask is whether the Oulu Phenomenon is just a result of the general development in Finland, or is it something more? The industrial changes that have taken place in Finland in recent years have led to the emergence of a range of new technology based on sectors such as telecommunications, electronics, computer software and biological and medical technologies. Such growth has manifested itself in the activities of firms such as Nokia, Polar Electro Elektrobit, Nethawk and Microcell, which now have considerable overseas activities (Männistö, 2002; Lundgren and Ylinenpää, 1998; Ylinenpää and Lundgren, 1998, Ylinenpää, 2001).

To view the whole development process from a wider perspective, the thesis firstly aims at analysing the birth and growth of technology-based industries in Oulu and Northern Finland, so as to understand the Oulu Phenomenon in its context, 1970 – 2002. The second focus of this study is to analyse and understand the dynamics of the technology-based industrial region, especially from the point of view of new technology based firms (NTBF) and demonstrate the changing role of different technological and industrial groups. The third focus is to conceptualise the technologically oriented region (such as Oulu Region) and its future prospects against current theories.

In the early stages of the Oulu Phenomenon, the "traditional big firm" (in Oulu`s case they were: Rautaruukki Oy, Kajaani Oy and Nokia Oy) played a crucial role. Later, however, the role of the smaller firms became more important, and eventually it was the subsequent interaction between the two that led to the creation of links between the public and private sectors. During the whole development process, a range of initiatives can be identified, which in turn forged new development stages. These stages became visible both in the emergence of certain types of firms and new industries in the region, and in the influence of the emerging industries on the firms in the region.

Due to the industrial restructuring that has taken place in Europe since the 1980s, research and development activities have been increasingly funded by governmental bodies through organisations such as Sitra (the Finnish National Fund for Research and Development) and Tekes (the Technology Development Centre of Finland), thus reflecting the increasing importance of technology in the industrial policies in the EU countries. Moreover, increased funding also gave rise to expectations of improvements in both employment and welfare. Figure 1.1 demonstrates the investment levels in Research and Development (R&D) as a percentage of the GDP (gross domestic production) in several OECD countries.

Figure 1.1 R&D Input in some OECD countries from 1985 – 2001.

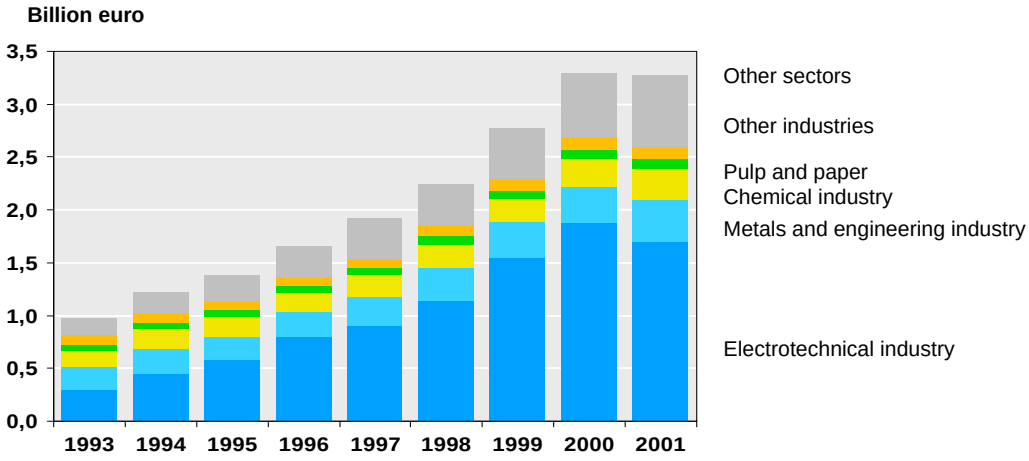


Sources: Tekes 2002; Statistics Finland, 2002

In Finland, the percentage of R&D input of the GDP grew from 1.5% in 1985 to 3.5 % in 2001. In 2001, only Sweden and Israel reached 4 % (Tekes, 2002). The development of technology was clearly a key issue in the industrial policy from the early 1980s. A new organisation, Tekes, was established in 1982 in order to manage this development and it became Finland's principal public promoter of research and development through its funding processes.

Figure 1.2 demonstrates the share of research and development in different industries in Finland between 1993–2001. In 1993 the research and development in the electro-technical industry was at 0.3 billion euro (i.e. 30 % of the total), rose in 2000 to 1.975 billion euro (i.e. 57% of the total), and decreased slightly in 2001.

Figure 1.2 The distribution of research and development by sectors in Finland



Sources: Tekes 2002; Statistics Finland, 2002

Looking at these national R&D input figures on a regional basis, it is clear that the Oulu Region has been one of the most successful in obtaining funding. In 2003, the Oulu Region's share of R&D input was 3.5 times more than the average in Finland, when this input is compared to the number of inhabitants. Other successful regions in this category are Salo, Tampere and Helsinki, which are noticeably the other main activity regions of Nokia in Finland.

In the early 1980s, the interest in technology concentrations developed further in Finland when the first Technology Park was established in Oulu as a joint project between the city of Oulu, the University of Oulu and local industry. Interest in this kind of concentration increased swiftly in Finland and also in other Nordic countries. By 1988 there were 7 technology/science parks in

Finland employing 2,140 people, and 11 technology/ science parks in Sweden employing 4,225 people (Vuorinen et al, 1989). In Norway and in Denmark the development was slower.

In Finland the early stages of this kind of regional development in the late 1970s came about through the setting up of industrial parks in certain municipalities (like Pudasjärvi, Nivala and Kajaani). The aim of these parks was twofold. Firstly, they were part of the central government's policy to stem rural depopulation from the north of the country to the south and to Helsinki in search of employment. A second objective of these parks was to provide premises for new firms operating in local, traditional industries such as wood processing and metal engineering. Many of these parks were later reorganised and some of them - such as those in Iisalmi and Nivala - are, at the time of writing, small regional concentrations of firms still functioning in a traditional fashion, while others such as the one in Kajaani has become much more 'new technology' oriented.

The founding of a Technology Park in Oulu was considered a breakthrough which forced the Finnish Ministry of Trade and Industry to re-evaluate the concept of Technology Parks within the Finnish context as follows: *"Vuodessa vomakkaasti selkiytynyt suunnitelma on poikimassa ainutlaatuisen ja monin tavoin perinteisistä teollisuuskylistä edukseen poikkeavan yrityksen."* (which translates as: *"In one year, the idea has developed strongly and is now spawning a new kind of Technology Park which deviates from the traditional model of industrial parks.")* (Malinen, 1982).

Founded in 1605, the city of Oulu has been the capital of northern Finland since the 18th century and as such has played an important part in the region's political economic and social life through its role as a major trading entrepot. In 1930, as the administrative structures changed, Lapland was separated from the province of Oulu, becoming a region in its own right, and Oulu was confined to being the administrative centre of its surrounding region. Beyond its administrative functions, Oulu has always been a busy centre of trade and communications in the north. For example, the tar trade was a major source of income during the latter half of the 19th century. From that era we have the term "*tervaporvari*", i.e. *"tar burgher or merchant"*, which encapsulated the combination of tar production, exportation, and shipping. Such people were the internationally oriented entrepreneurs of their era despite their apparent geographic isolation.

There is a close connection between administrative and commercial development and the technological development of the Oulu Region. For example, the extension of the railway network

to Oulu, and later the production of electricity in Oulu were both administratively and commercially important points in the development of the area. As the strength of the tar trade began to decline in the early 20th century, due to the emergence of steel vessels, the industrial basis of the region entered a phase of transition. Mechanical wood processing began to establish itself in the deltas of the great rivers in Finland, and Oulu was no exception in this development. The raw materials needed in the sawmills were transported downriver to the mills, after which they were shipped abroad. However, as wood processing was insufficient to sustain the local industry, from the 1930s onwards a diversification programme was implemented, leading to the birth of pulp and paper production.

Up to the 1970s, the development of the Oulu Region followed a typical path in Finnish terms. The industrial structure was based on the development of traditional industries. Oulu, however, was different in one respect, namely it had a university. In the 1980s 'something changed' and Oulu started to appear frequently in the media, as the city started to invest in new technologies and knowledge-based industries. The founding of Oulun Teknologiakylä Oy, the first Technology Park in the Nordic countries, was a crucial moment as the regional development took its first steps in the direction of other regions such as Silicon Valley, Route 128 and San Antonio in the USA, Cambridge, the M4 Corridor and Silicon Glen in Scotland (Mäki, 1998; Hannula, 2002; Oksman, 2002; Similä, 2002; Veikanmaa, 2002).

1.3 The rebirth of Oulu - the roles in knowledge development

The development of Oulu from a conventional Finnish town into a centre of knowledge-based industry can be traced through a series of activities from World War II until today (Mäki, 1998). Mäki distinguishes three stages in the development of the city: 1) the era of reconstruction and corporations 1945-1959, 2) the foundation of the University (1958) and the growth of the city 1960 – 1979, and 3) the emergence of the technology city from 1980 onwards.

1. The era of reconstruction and corporations, 1945-1959

Heavy bomb damage during World War II destroyed large areas of the city. In the reconstruction that followed, the Merikoski hydraulic dam was built in the middle of the town to restore and increase the power supply. Additionally, the era of corporations refers to the time when two pulp factories, Oulu Oy and Toppila Oy, and the fertilizer producer, Typpi Oy, dominated the industrial

activities of the city. Until the 1970s, these two industries were the biggest employers in the city of Oulu, which by then had a population of 40,000 inhabitants.

2. The birth of the University (1958) and the growth of the city, 1960 – 1979

The University of Oulu was founded in 1958 and its operations started in 1959. The university's first faculties were education, engineering and medicine. The faculty of engineering grew quickly and soon expanded into electrical and mechanical engineering. From a developmental point of view, these two departments, along with the medical school, have played a crucial role in the industrialization of the city. During this period, the size of the city grew and, by 1965, the city's population had grown to over 80,000 inhabitants (see Figure 4.1).

3. The emergence of the technology city, 1980-

The concept "technology city" became a reality in the mid-1980s, as the city council started to actively promote the foundation of a Technology Park near the university campus at Linnanmaa. On June16 1984, the city declared itself a technology city, and the city was advertised accordingly thereafter. Oulun Teknologiakylä Oy was founded in 1982 to steer the technology park project. At the time of writing, the population of the city of Oulu is almost 120,000, and the surrounding areas have a population of approximately 50,000.

1.3.1 When did new technology come to Oulu?

The concept of new technology is rather vague and largely dependent on time and context, and it will be defined later with respect to the Oulu Region. As will be seen later, Nokia Electronics and the development of the telecommunications industry have played major roles in the development of Oulu as a technology centre. Nokia Corporation started with a cable factory in Oulu in the 1960s. The electronics industry had started elsewhere in Finland in Nokia in the 1960s. In the early 1970s, Nokia started the production of U.S. military radio equipment under licence for the Finnish defence forces. The production of non-military radio equipment started quite soon afterwards in Oulu, which led to a rapid development of the industry (Wikstedt, 1999). Other important firms for the knowledge-based industry which started early in Oulu were the electronics branch of Kajaani Oy and Oy Paramic Ab (later Aspo Oy).

The establishment of a high technology area

Northern Ostrobothnia is the official name for the greater Oulu Region (i.e. Oulu city and province). As early as 1978, the five-year-plan of the Spatial (Regional) Planning Office of Northern Ostrobothnia (currently the Regional Council of Northern Ostrobothnia) included the idea of creating a "Silicon Valley" in the north of Oulu Region. From that starting point, the regional plan for the area (Pohjois-Pohjanmaan Seutukaavaliitto, 1981) proposed the founding of a "high technology area" near the University and the VTT laboratories. The plan explicitly states:

"..data processing and telecommunication-based industries especially can be identified as having international potential, and Finland should take its share of the growth of these industries. In an attempt to be part of that potential growth, resources are the key factor to be developed. Oulu should be one of those locations that could be the centre of these high technology industries."

In the realisation of the project, the Spatial Planning Office proposed that a suitable site should be reserved near the university as the location for the knowledge-based industries. In addition, it was proposed that an organisation should be founded that would take care of the construction and maintenance of the facilities (Pohjois- Pohjanmaan Seutukaavaliitto 1981 - Northern Ostrobothnia Spatial Planning Office).

The city of Oulu takes initiative

Towards the end of the 1970s, Oulu City Council began to warm to the regional council's suggestions and saw the possible advantages of locating a technology park within the vicinity which it hoped would generate new industrial growth and generate employment. In March 1980 a working group to prepare measures for developing an electronics-based business in Oulu was set up. The final report of the working group proposed that a technology park company should be established in Linnanmaa, an area near the university. In turn, the city council decided in the spring of 1981 to set up a committee to launch the technology park project. Oulun Teknologiakylä Oy was founded on March 31 in 1982, and the first partners in the effort were the city of Oulu, the University of Oulu, KERA (the Regional Development Fund), and 18

privately owned firms. The first premises of Oulun Teknologiakylä were built in Linnanmaa in 1986 – before that the company had temporary premises – and since then, the Technology Park has grown rapidly. In 1992, a second park, Medipolis, was opened nearby to concentrate on medical technologies (Similä, 2002).

The transition of the business policy of the city; from "passive" to "active"

On September 19 in 1983, the city council approved its new business policy for the five year period from 1983-1988. The most important aspects of this were that measures taken in the business policy were to be no longer "*passive*" but "*actively oriented*". The term "*passive*", referred to activities, which aimed at ensuring the stability of the general business environment. The term "*actively oriented*" meant that the "*city of Oulu would act as the initiator and participant to utilise the personnel and financial resources of the city, either directly or indirectly, to create jobs or to maintain existing jobs*" (Oulun kaupunki, 1983).

The emphasis of the new business policy focused on:

1. investment in know-how
2. investment in supportive entrepreneurship
3. an increase of regional cooperation in the business policy measures.

To implement this policy, the city established an Office for Economic Affairs at the beginning of the 1980s to support the foundation of the Technology Park and to maintain its development (Oulun kaupunki, 1983)

The business policy of the whole region turns technology-based

In the early 1990s, Finland and Oulu, along with several other countries, entered a period of recession. In the uncertain days of 1993, the Oulu business policy was in need of updating, even though by that time Oulu had defined itself as a 'technology city' and the knowledge-based industries employed several thousand people. In the introduction to the policy update, it was stated that the initiative in regional development no longer rested with the national government but on the initiatives of the regional authorities and firms. Thereafter, about 40 company managers and other key people of the region came together and assumed an active role in further updating the Oulu business policy. As a result of these efforts, a new development strategy for the Oulu Region was

created. The focus of the strategy was extended to include the fields of telecommunications, optoelectronics, biotechnology, and medical technologies. The strategy further included cooperation with the Ministry of the Interior in the so-called Centres of Expertise project. Later, this project was evaluated as the best of its kind in Finland.

Centres of Expertise Programme initiated in 1993

The Finnish Ministry of the Interior launched the Centres of Expertise project early in 1993. In the 1970s and 1980s, the focus of regional development was to encourage less developed regions to activate their local business policies. In those days, the firms in less developed regions could obtain some tax benefits, subsidies for investments and new staff, and also some risk capital. The aim of this was to lessen the disadvantages of the less developed regions arising from local factors such as location, quality of employees, lack of industrial traditions and so on. In the 1990s, this focus was changed, and the policy became much more technologically-oriented. The new approach was to focus on regional strengths and build upon these strengths rather than simply eliminate the disadvantages (Ahola and Kortelainen, 1997; Sisäasiainministeriö 1997; Laaksonen, 1994).

The experience gained in the Oulu Region from this kind of approach to development influenced subsequent national policy. The Centres of Expertise Programme was also an extension of the progress at national level to harmonise the activities of the regional universities, established in the 1970s, and bring them in line with the networks of the centres of technology set up in the 1980s. To support this there was an increase in funding for research and development programmes (see Figure 1.1). The aim of the first part of the overall programme was to pool local, regional and national resources to develop specific internationally competitive fields of expertise. The first period was between the period 1994 – 1998 and was based on eleven centres, of which Oulu was one. The Council of State extended the programme in the second period (1999 – 2006) by nominating new fields of expertise and new Centres of Expertise (i.e. 14 regional centres and 2 industry specific networked centres) (Sisäasianiministeriö/Ministry of the Interior, 2003).

1.3.2 Is there an Oulu Phenomenon?

The speed of Oulu's growth and development attracted considerable attention nationally and internationally as the following quotations indicate:

In an article *"Oulupolis, rössypottukaupungin kosto"*, the development of Oulu was described as follows:

"The city of Oulu and surrounding areas are the best of the "silicon valleys" in Finland. In less than two decades Oulu has become one of the most important centres of high technology. Some claim that the technology development process was started by the establishment of the University of Oulu, others by the establishment of the Department of Electronics in 1966, while there are some who maintain that it was the Nokia Radio factory (1974) or the Aspo Oy opening speech (1980) or the establishment of the Technology Park (1982). Whatever the origin, the model is by no means new; it was copied from the original Silicon Valley in California. However, Oulu was nevertheless the first one in Finland and the Nordic countries both by luck and its own initiative". (Suomen Kuvalehti 44/1996, Finnish Current Affairs Magazine. Author`s translation).

Similarly, an article in *Business Week* referred to what was happening in Oulu in the following terms:

"In the Cold and the Dark, High-Tech Heat

It`s a long trek to Oulu, Finland, a Nordic village some 800 kilometres from Helsinki and only 230 kilometres from the Artic Circle. But this outpost attracts a stream of visiting Japanese and American technology execs. Some even stay foor good, despite the long winters. The attraction: Oulu Technopolis, the world`s northernmost science park and home to the world`s best telecommunications and electronics technology.

Oulu`s success is the result of years of planning. Since the early 1980s, Finland has pushed to make high technology the center of its economy, replacing wood and pulp and paper products. Cellular-phone star Nokia Corp., whose stock has risen over 2000% since 1992, is the country`s best-known success story. But it`s only one of many Finnish technology pioneers. Oulu alone has 100 start-ups in the fields from software and sensors to optoelectronics and lasers". (Business Week, September 25, 1995)

In the Oulu Region, the development of the high technology industries has been described as the "Oulu Phenomenon" (Tunkelo, 1988), characterised by the following aspects:

- the emergent group of high technology firms was from the beginning involved in the fields of electronics, software engineering and telecommunications. Biotechnology was also seen as a promising industry for the future;

- the majority of the established firms were small and privately owned; only a minority of the firms was a unit or subsidiary of bigger firms;
- these firms were founded in a short period in the late 1970s or early 1980s, and an increase in the foundation rate of the firms was observed in the late 1980s;
- the technology-based firms strongly emphasised research and development activities, small production volume, and the importance of subcontracting activities;
- in line with the Cambridge experience, both direct and indirect relationships with these firms and the University and other research organisations were typical.

The emergence of the Oulu phenomenon was summed up as follows by Tunkelo (1988) in that '*The Oulu Phenomenon was brought about through positive environmental and individual forces, and it is characterised by synergy-generating innovative processes*" (Author`s translation).

The developments in the region of Oulu have also been compared to the developments in the nearby Luleå region in Sweden (Lundgren and Ylinenpää, 1998). They found that the Oulu Region has developed much more rapidly, and list the following possible explanations for faster development of the Oulu Region:

- the national role of the city of Oulu;
- regional co-operation with different actors;
- the importance of Nokia both as a customer and a partner with a demand for SMEs;
- the industry distribution is bound up with new industries instead of older ones.

1.4 Research context

Earlier research

Industrial concentrations based on new technologies and their development have been analysed in the U.S.A. and Canada (e.g. Markusen et al, 1986; Smilor et al, 1988; Saxenian, 1994; Markusen, 1996; Southwick, 1998; Wolfe, 2003), in Europe (e.g. Keeble, 1989; Oakey, 1995; Oakey and Mukhtar, 1998; Simmie, 1998; Sternberg and Tamasy, 1999; Lawton Smith, Glasson, Simmie, Chadwick and Clark, 2003), as well as in Asia (e.g. Sternberg, 1998; Park, 1998). New technology is a time-dependent concept, and as the theory of the business cycles of industrial products was developed (Kondratieff, Schumpeter etc.), technological development was recognised as a trigger

factor in this development. In 1934, Schumpeter presented his theory of business cycles, and five years later his theory of product cycles. The latter theory has subsequently been developed further (Vernon, 1966; Kotler, 1982). Markusen's profit cycle model, for example, describes how global development can transform industrial structures. At the different phases of the profit cycle, the competitive factors in different regions also change, which in part explains the cyclical change in industrial structures (Markusen et al, 1986).

National and international concentrations of high technology can be investigated from several angles. These include the firm structure of the region (e.g. Markusen, 1996), the industrial clusters (Porter,1990), firm community model (Lovio, 1993), the internal dynamics of the concentration (Pouder and St John, 1996, Low; Abrahamson, 1997), the Triple Helix Model (Etzkowitz and Leydesdorff, 1997 and 2000) and networking structures (Keeble and Lawson, 1997). There is also the Innovative Mileu- model (Aydalot and Keeble, 1988; Maillat, 1991; Gordon, 1991; Camagni, 1991 and 1995) which tries to define the characteristics of a region where new technology can be utilized effectively in production systems.

In the discussion of technological cycles, considerable emphasis has been laid on the importance of long wave cycles. These long cycles bring in a temporal dimension to the subject, which otherwise can easily be overlooked. Development work based on new technology has attained a significant position during the latter half of the 20th century, but it should be borne in mind that there has always been technological development, and that new technology has always caused significant upheaval and structural change (Hall, 1985). For example, after World War II, development based on new technology started actively in the U.S.A. (in Silicon Valley and Route 128). The awarding of military contracts in research and development work during the Cold War was a major force behind the rise and acceleration of the development of new growth industries in both areas even though their industrial cultures were different, one being in an agricultural area, the other being in a well-establsihed industrial district (Markusen, 1986; Saxenian, 1994). Nevertheless, the key point is that academic-industry links and technology and innovation transfer has been the subject of numerous studies particularly in the context of science and technology parks (e.g. Autio, 1997; Bernardy, 1997; Lawton Smith, 1991, 1996, 1997 and 1998; Longhi, 1997; Mäki and Sinervo, 2003; Sternberg et al, 1999; Quintas et al, 1992; Männistö, 2002).

Many models describe the growth of small and medium size firms (Salonen, 1995). The growth process is seen as a periodical growth process from one stage to the next (Greiner, 1972; Churchill

and Lewis, 1983; Kazanjian, 1988; Kazanjian and Drazin, 1990). In these models the number of stages varies from three to six. There are different stage variables such as size, managerial style, organisational structure, formality, strategic goals, and the founding owners' involvement. The role of such variables, however, changes as the firm grows and such changes in firm growth, structure and behaviour has been anlysed, as willl be seen later by a number of authors (Bullock, 1983; Kazanjian, 1984; Van De Ven et al, 1984; Oakey, 1995; Salonen 1995 and Yli- Renko and Autio, 1996).

1.4.1 Special Characteristics of Oulu

The development of Oulu into one of the leading concentrations of technology in Finland has been going on for more than twenty years. This development is the outcome of several factors. The founding of the university created the conditions for the development of knowledge and basic research. The multilateral collaboration between the City, local companies and the university led to the birth of the first Technology Park in the Nordic countries, which has grown rapidly. This development took place without the support of any particularly strong industrial tradition – although a long tradition in trade and commerce was part of the history of Oulu. In the case of Oulu's recent development, however, the role of small and medium-sized enterprises has been crucial. Approximately 40 per cent of the new jobs created in the Oulu area in the past two decades have been in such firms.

At the time of writing, the region has had almost 20 years' experience of an industrial policy based on high-technology industries. The author of this text has had the opportunity to follow this development through his own work without being involved in the actual measures and realisation of the policies. However, despite the importance of these activities for the area, no extensive analysis has been made of the technology-based industries of the region. Those studies which do exist cover only specific aspects of it (e.g. Tunkelo,1988; Koistinen, 1999; Äikäs, 2001; Männistö, 2002).

From these starting points, the wider purpose of this study is to investigate the reasons for industrial growth in high tech industries in Northern Finland between 1970 and 2002.

The study is organised as follows, it:

1. examines the role of national and regional initiatives with respect to the creation of new technologies in Oulu and investigates the roles of the university, of VTT, of the research laboratories and of Nokia in the subsequent industrial change
2. analyses the role of New Technology Based Firms in the industrial evolution in Oulu and distinguishes the various stages of evolving growth in different sectors;
3. projects this development against the theories, used in this research, in order to conceptualise the industrialisation process

1.4.2 Elements of the theoretical framework

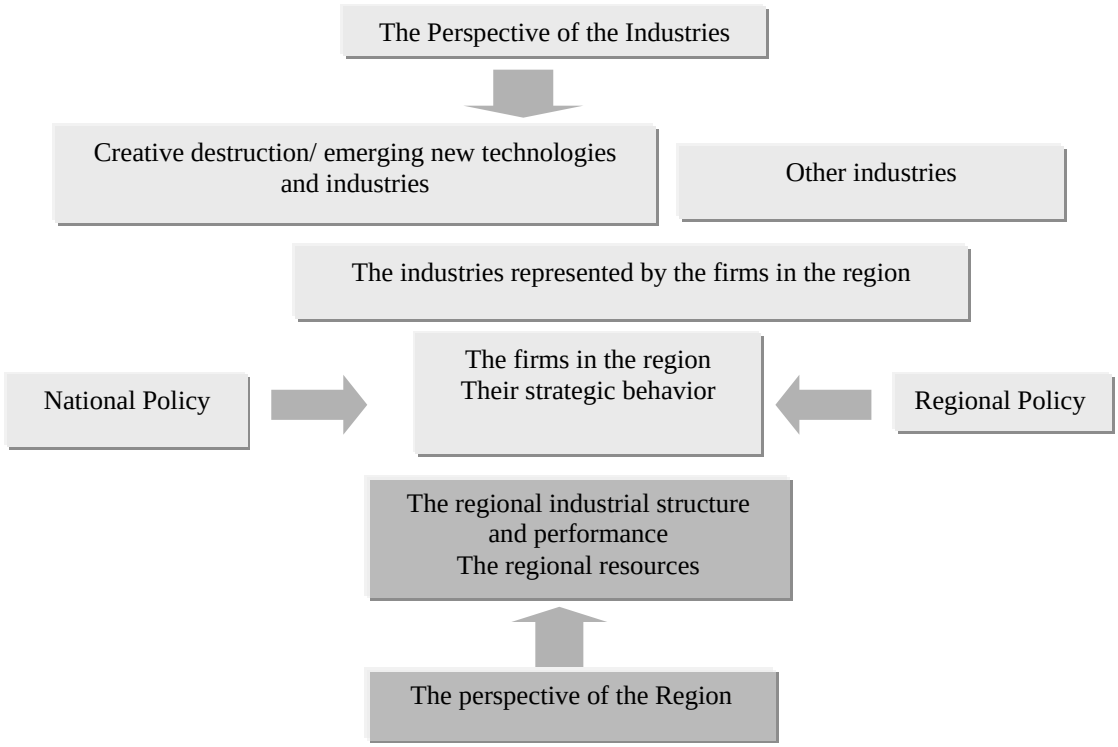
Over the past thirty or so years of new industrial development in Oulu there have been several actors and activities, and clearly the interaction between the various actors has changed and the "driving forces[1] " behind the developments have changed over time.

As stated above, this thesis seeks to examine this interaction and investigate the rise of new technology based industries in the Oulu Region from 1970 until 2002. The focus is on the industrial development and regeneration, the links between the various actors, - i.e. the national and local governments, institutions such as the university, VTT and other research centres, the firms themselves, - and the impact their respective functions and behaviour patterns have exerted on industrial growth in their attempts to strengthen the local economy.

Figure 1.3 illustrates the theoretical framework of analysis, with the firms in the region at the centre of the diagram. In addition to representing an industrial and regional structure, at the same time the firms represent the link to wider industrial development in both existing and newer sectors. In the technology-based firms, the dynamic factors are stronger than in the traditional industries, which have a history of more stable conditions (but perhaps no future). The regional industrial development can be assumed to be the stress between the industries in existence, the regional demand, the regional conditions and the region's competitiveness from the firms' point of view. In technology intensive industries, the business cycles are fast moving and this often leads to a rapid evolution in industrial structures.

[1] A Driving Force is a variable which has a relatively high level of explanatory power in relation the data displayed in the cluster (Van der Hajden 1997)

Figure 1.3 The theoretical framework used in this thesis



Source: Author`s own diagram

The theoretical framework of this study

The theoretical framework of this study has been constructed through analysing the strategic behaviour of the firms in conditions where:

- development is taking place in a fixed region, where high technology industries predominate;
- the internal dynamics of the firm and groups of firms are essential to growth;
- the region is strongly connected to the development of a new industry or industrial cluster;
- regional initiatives, activities and actors in this development process vary over time;
- the development interacts with the national industrial policy.

Based on the above, the theoretical framework employed in this study is based on three main theoretical frames which are further elaborated on in the the next chapter which consists of a review of pertinent relevant literature.

The first frame demonstrates the growth and the development processes of the firms as part of the industries or sectors to which they belong, how cyclically they have evolved over time and how they have had an impact on the region.

The second frame discusses the role of national or regional initiatives in order to create new technology-based industries. A focal point is the role of the Science/Technology Park concept. This concept has enjoyed a strong position in regional development particularly since the late 1980s in Europe. Oulu is one of the early pioneers in Scandinavia, but it is also much more than a Science Park.

The third frame consists of understanding the regional industrial structures and also examines the role of networks and networking.

1.5 Structure of this study

As discussed earlier, Oulu`s industrial development went through several stages. To facilitate an understanding of this, Table 1.1 illustrates the various stages of this and the remainder of the thesis is essentially an expanation of this.

Table 1.1 Pre-understanding of the Oulu Phenomenon

Issues to be taken into account	**The Formative Stage 1970-**	**The Consolidation Stage 1980 -**	**The Fast Growth Stage 1990-**	**The Diversification Stage 2000-**
Situation in Finland	Traditional industry dominates Trade with Soviet union significant. National investments in education	National regional development policy strengthened, Technology policy established	Economical recession Industrial restructuring ICT industry emerges Joined EU	"post growth" situation Migration inside the country, concentration
Situation in Northern Finland	Strong out-migration Industrial restructuring	Industrial restructuring strengthening		Migration, Polarisation
Situation in Oulu	Industrial restructuring, Educated workforce	Slowly growing Trust in technology-based development	Resource shortages National example of new regional development model	Growth decreasing
Leading Paradigms	New technology-based industry possible (Northern Silicon Valley)	The role of entrepreneurship in New Technology Based Firms (NTBFs)	Growth by clusters Dominance of technologies	Growth Agreement (Growth will continue) Multipolis concept, Oulu can catalyse the growth in other regions
The NTBFs point of view	New industry based on growing NTBFs is possible	New generation of NTBFs, which can grow	ICT cluster takes the dominant role	Clusters in different stages Confusion
Main actors	Visionaries in the university And in the traditional industry University labs Research labs	Entrepreneurs City of Oulu, University of Oulu, Industry (Nokia) Research labs Technology Park	Clusters dominant (=ICT) Education Institutes Technology Park	Nokia Growing NTBFs Business Angels Multinationals University labs Research labs
Traditional industry	Jobs in the Oulu Region are decreasing Growth based on new technology businesses	Nokia begins to grow in electronics	Nokia concentrates on ICT Paper industry going toward conglomerations	
Other relevant factors	Spirit of regional pioneers, Resources created for further development, Nokia multibranch company having some activities in electronics in Oulu Region	Regional focus in indigenous NTBFs Nokia buys Firms	The focus on Clusters and Technologies Nokia sells firms The international ownership grows	Indicators of a break in development Structures changing

Source: Author`s diagram

The first chapter of this study analyses the development in the Oulu Region. Special attention is paid to the critical points in the development, to the decisions taken, and to the events resulting from them. The change of gear in the industrial policy of the City of Oulu, from reactive to proactive in 1982, was the first sign of the start of a new type of co-operation between the City and the companies. The result of such collaboration was that the City's industrial policy could be

regarded as very *"enterprise-driven"* by the beginning of the 1990s. In this respect, comparisons are made with other cases and, finally, certain related key concepts are defined.

The first part of Chapter 2, as noted earlier, introduces some of the most relevant theories for describing the growth of an industrial region based on new technology. Several approaches are described for analysing the development of a technology intensive region. At the end of the chapter a theoretical framework is presented to conceptualise the changing business context and its influence on the growing NTBFs.

Chapter 3 gives an account of the methodology used in this research. The research has been carried out longitudinally, covering the years between 1970 –2002, and the research is both an explanatory and analytical case study of the Oulu Phenomenon.

Chapter 4 is the first empirical part of the study. It covers the evolution of the Oulu Phenomenon as a whole. The 'Phenomenon' is projected against the changing regional and local demands and also against the changing national development and indicators positioning the Oulu Phenomenon in the national framework. The development of the regional business strategy and of the Technology Park (later Technopolis) are also investigated. Until the middle of the 1990s, the Technology Park was a vehicle responsible for the construction and maintenance of industrial premises, but since then its role has become more extensive as it became a key actor in regional development generally.

Chapter 5 is the second empirical part and describes the development of Nokia Oy, its changes in the late 1980s and 1990s, and Nokia's role in Oulu overall. Nokia is the most important firm in the renewal of Oulu's industrial structure and in many ways came to play the role of an "*anchor firm*" in the process in the 1990s.

Chapter 6 is the third empirical chapter, which analyses the industrial development of the new technology based firms in the Oulu Region between 1970 -2002. Special attention is paid to industrial or sectoral evolution, clustering and also the evolving links between the regional institutions and industry.

Chapter 7 is the concluding chapter. In this chapter, the key elements of the development are presented. The development is projected against relevant theories and a concept for demonstrating

the development in the Oulu Region is presented.The latter part of chapter 7 considers the reliability and validity of the study and gives some recommendations for further research.

2 Literature Review

INTRODUCTION

This chapter outlines the central theories, which can be used to explain the growth of regional concentrations of industry. They particularly focus on the rise and development of areas of high technology-based industry. Concentrations of technology can be classified using the various models of the concentration structure (Markusen, 1996; Porter, 1990; Lovio, 1993; Saxenian, 1994; Keeble and Lawson, 1997) or, alternatively, on the basis of their internal dynamics and developmental stages (Low and Abrahamson, 1997; Pouder and St John, 1996, Ahokangas et al, 1999). Similarly, cluster theory can be used and has been used in Finland since the 1990s, to analyse the development of new technology based industries (Hernesniemi et al, 1995).

This chapter is divided into three main parts. The first part presents the theoretical background to industrial cycles, the development of industries and industrial clusters, growth models for small and medium sized companies, the industry-company interface; the process of regional clustering and the company community model. The second part of the chapter covers the Science / Technology Park concept, its origin in the United States, its entry into Europe and the different ways of adopting the concept. This helps contextualise the Oulu Phenomenon. The third part covers industrial districts and their key features, the concept of an innovative milieu and, to some extent, the business and social networks. The fourth and concluding part will discuss the Oulu Phenomenon within the context of competing theories and justify the approach taken.

2.1 The perspective of industries

This part of the chapter discusses the development of industries, the development of individual companies and also the interface between the industry and companies or group of companies (evolving cluster).

Industries form an environment for individual companies. When they are growing, they are more or less linked to certain industrial development processes. The strategic behaviour of companies is to understand the industries in which they are involved, to understand the critical success factors within the industry, to recognise their own position within that industry and be aware of future

changes. In evolving, emerging industries there are differences in terms of speed of evolution when compared to traditional industries. The concept of creative destruction (Scumpeter, 1934) highlights these changes which destroy some old structures but also create new ones (Kondratieff, 1924; Schumpeter 1934) .

2.1.1 Industrial development and long cycles

In 1924, Kondratieff argued that capitalist development follows a regular cycle, consisting of a long cycle of about fifty-five years, from boom to bust and then to boom again (taken from Hall, 1985). The triggering factor in this development is that it is technology innovation that makes the growth of the companies happen. After the growth stage, the markets mature which is then followed by decline and eventually new innovations repeat the cycle. Later on, when Schumpeter developed the idea of the business cycle, he used the terms boom and depression in the economy. The boom ends and the depression begins and time elapses before the products of the new enterprises can appear in the market and an upwards trend is resumed (Schumpeter, 1934).

Some forty years later in Germany, Gerhard Mensch published a study in 1979 in which he showed that the historical peaks in the use of innovations paralleled the economic cycles presented by Kondratieff and Schumpeter. According to Mensch, the peak years were 1764, 1825, 1886 and 1935. Building on his own model, Mensch estimated that the next peak in the innovations would be in 1989 (Mensch,1979). Although Hall (1985) and others have criticised Mench's work, there is general agreement between them that long cycles do exist. However, they disagree about their length and the explanations of their occurrence. The novelty in Hall's work is that, despite his analysis of English regions such as Lancashire, Shropshire, the Black Country and the North East during earlier long wave cycles, he eschews geographical determinism and argues that economic success lies with the country and the region and the city that innovate and keep one step ahead of events (Hall,1985). Maintaining a lead depends upon three things, firstly, on people who are capable of initiating technical, organisational or marketing breakthroughs; secondly, on entrepreneurs who acknowledge which of the breakthroughs are the most appropriate and marketable; and, finally, on the lack of traditional industrial traditions which might act as inhibiting factors in promoting new developments (Hall, 1985). A further contributor to this debate is Marshall (1987). He accepts Hall's spatial analysis, but disagrees with Hall's contention that long wave dynamics can be accounted for simply in terms of the social distribution of innovative entrepreneurs. In Marshall's view, spatial dynamics must be seen in the context of social relations

which help to frame the production processes within specific regional economic, political and social frameworks.

Long cycles may appear in different countries and in different regions at different times. According to Kondratieff, the first cycle was dominated by Great Britain, although the U.S. and Germany entered the game during the second cycle – and these two countries then dominated the third cycle. The fourth cycle was estimated to start with World War II and to have ended in 1984. This era was initially dominated by the U.S. but was in its later stages challenged by Japan in some areas. According to Schumpeter, the economy itself does not explain cyclical fluctuations, but he notes that entrepreneurial behavior is one of the explanations for economic recovery and the initiation of a new boom. Schumpeter says: *"The new does not grow out of the old but appears alongside of it and eliminates it competitively. It so changes all the conditions that a special process of adaptation becomes necessary."* Schumpeter (1934) claimed that most innovations cause economic development. In his article, "*Business Cycles",* he discusses several development cycles. The Industrial Revolution (approximately 1785- 1842) was based on developments in cotton spinning and weaving, and the smelting and refining of iron as well as on the steam engine. The second revolution was based on the emergence of the railways and on the new process of steel production, i.e. the Bessmer process (1842-1895). The third industrial revolution started in the mid 1890s and was based on the development of the chemical industry and on the emergence of car manufacturing and electrical engineering industries. This era continued up until the 1930s when Schumpeter developed his theories.

Schumpeter's analysis of what happens when a new cycle emerges sounds very relevant even today: *"The counter-movements do not merely obstruct development; they put an end to it. The development which then starts is a new one, not simply the continuation of the old. The new development proceeds from different conditions and in part from the actions of different people; many old hopes and values are buried forever; wholly new ones arise."* (Schumpeter 1934).

While Schumpeter and Kondratief highlighted the cyclical development caused by technological innovations, Rostow (1960) emphasises the equal importance of the ability of nations to capitalise on these and innovate to achieve further economic development to increase production, productivity and economic and social welfare. Following up on this theme, Rostow argues that this kind of development consists of stages like take-off, maturity and mass consumption, etc. He also analyses several countries in an attempt to define the timing of these stages. According to him, Great Britain

was the first country to take-off on the road to industrialisation in the late 18th century. France, the USA and Germany followed some decades later. Being an early starter in this development; Great Britain had specific advantages such as location, raw materials, trade flexibility, a capital market and national and local transport infrastructures, which were suitable for the time.

The theory of long cycles suggests that stable situations do not last long. Approximately every 50 years or so the industrial structures change, and in between smaller changes can also occur (Schumpeter´s second wave). The question then arises, is this new technology in our time an expression of Kondratief's 5th wave? There is no definite answer to this. When the new technology is currently defined generally as a breakthrough based on semiconductor technology, it has to be realised that this technology is by now more than 50 years old.

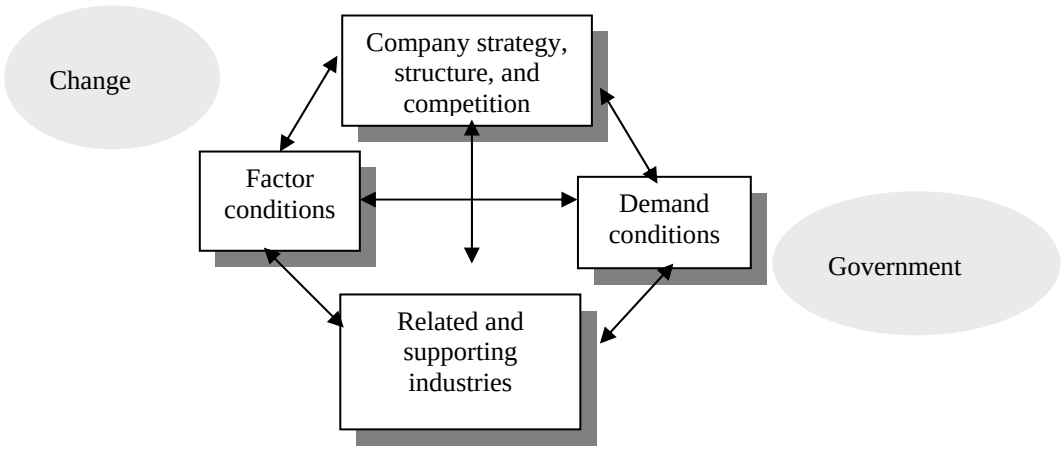
2.1.2 Observation at industry level

One way of analysing industrial development is to use the Diamond model, developed by Porter in 1989. This kind of analysis became a common way to develop industrial policy in Finland in the1990s. The Diamond model is based on the theory presented in the Strategy in Competition theory of the 1980s, and extends the theory to industry and national levels (Porter 1990). The model comes from the analysis of successful industries and countries, and points out the factors, which explain that success. Hall (1985) also presents similar factors in his own analyses. While the long cycles illustrate the early stages in new industries, Porter goes further and tries to explore the several factors behind these to explain industrial or sectoral development. In his studies, however, Porter concentrates only on successful industries and does not discuss those which fall by the wayside. In other words, his study is only partial. According to Asheim (Asheim, 1995), Porter's research is clearly rooted in the ideology of Schumpeter, because competition is not only based on prices but also on technological factors. Porter's way of analysing factors and structures on a national level can be linked also to the maturity of a country to develop and maintain the use of raw materials and other production factors, institutes and political systems, as discussed earlier by Rostow (1960).

Porter (1990, 1991) studied the development and sustainability of competitive advantages in developed industries and of various industrial segments at national level. He discusses four forces, as shown in Figure 2.1, that shape and affect the competitive environment of companies: 1) the factor conditions, 2) the demand conditions, 3) the related and supporting industries, and 4) the

company's strategy, structure and competition. The company's environment is defined through these four forces as companies emerge and compete with each other. Porter claims that success in knowledge intensive industries calls for advantages in all of the aforementioned aspects and the interplay between the forces gives rise to national advantages that foreign competitor companies can find difficult to overcome or imitate. Only random governmental forces may affect the national environment beyond the previously mentioned forces. Chance, particularly, may produce discontinuous random changes that may reshape industries. Governments in turn may control or affect competitive forces through purchasing policies or other political means.

Figure 2.1 Porter's diamond model



Source: Porter, 1990

Factor conditions

According to Porter, the most important factor conditions are not acquired, but created through the transformation processes which the companies undergo in their industries over time. From the point of view of factor conditions, the speed of creation and specialisation of factors is critical to the process of transformation. Porter discusses factor conditions in several subcategories: human resources (amount, skills, costs), physical resources (natural resources, location), knowledge (scientific and other), capital (finance and its costs), and infrastructure (quality of life-related conditions). He also divides the factors further into two categories: basic factors and developed factors. Basic factors include raw materials, the climate, and a skilled and educated labour force.

Developed factors include a highly educated labour force and an appropriate infrastructure for information transfer. The latter two, he considers, are the most important from the competitive advantage point of view; they enable the creation of high quality competitive advantages through investments in employees and technologies. Developed factors are also difficult to acquire from the global marketplace. Another distinction Porter makes is the difference between general and specialised factors. General factors include e.g. roads and the availability of a skilled labour force. Specialised factors concern e.g. industry or customer specialised factors. In technology-based industries, it is important to bear in mind that factor erosion takes place rapidly i.e. specialised factors turn into general ones.

New Technology-Based Companies and Factor Conditions

Moving on from Porter, Yli-Renko and Autio (1996) point out the importance of new technology-based companies (NTBFs) in the development and creation of knowledge-intensive factors, as the NTBFs act as a channel through which information resources are transferred from academic research into the business community. They raise the flexibility and communication abilities of the NTBFs in the innovation adoption process and play a significant role in the national development. NTBFs are viewed as a type of extension of research organisations and interact closely with these in their quest for trained employees. A similar role for NTBFs can be found also in the Triple Helix Model (Etzkowitz and Leydestorff,1997 and 2000).

Demand Conditions

Domestic demand conditions can be discussed from several angles. Sophisticated and high income customers may advance the development of the companies in cases where the customers require world-class quality. Moreover, short geographical and cultural distances may also enhance a company's ability to find new demand and it make it easier to maintain a close relationship with the customers during development processes. Competitive advantages may also be obtained if the needs of the foreign customers replicate those of domestic customers. Furthermore, the early maturation of domestic markets may force firms to continue innovating and developing the product as well as cultivating alternative markets. Finally, the role of technology-based companies is said to encourage new forms of behaviour among companies through alliances, networking and subcontracting sometimes across a range of industrial networks to cope with changing patterns of demand and product development (Porter, 1990; Yli- Renko and Autio, 1996).

Related and Supporting Industries

The companies in the supporting industries must be able to provide input factors effectively and efficiently with low costs rapidly and in the desired form. The most important factor, however, is the existence of co-operative networks that can enhance innovation and development. For example, the domestic end-product producers benefit if subcontractors are subject to global competition and are capable of either product or process innovation themselves. In addition, the transfer of knowledge from research and education organisations to companies is an important role, when viewed from national and international perspectives (Yli- Renko and Autio, 1996).

New Technology-Based companies and Related Industries

Yli-Renko and Autio (1996) also discuss the role of NTBFs in related industries. According to them, quite often NTBFS, besides acting as external research and development resources for their larger customers, can enhance the information flow between different clusters of companies, and thus the emergence of new NTBFs can be seen as a sign of the emergence of a new industry or cluster. NTBFs, therefore, play a significant role in restructuring and developing industries. In Finnish industry, for example, NTBFs have also played a role in the restructuring of research activities as will be discussed in Chapter 6. Thus it is reasonably safe to assume that new technology-based companies can be a source of competitive advantages in an industry and thereby help to initiate industrial renewal.

Clusters, as defined by Porter, on a national basis have a strong position in the Finnish industrial policy (Hernesniemi et al, 1995). Important though Porter`s model may be, it does not fully explain this type of growth. in a Finnish context. In this instance, Lovio`s approach is rather more rewarding. Taking on board the fact that the Porter model underlines the role of education sytems, a skilled work force, available research institutions etc., he argues that in line with the Triple Helix approach (Etzkowitz and Leydestorf, 1997 and 2000) that one needs to go further and so his research focuses heavily on the degree of cooperation and competitiveness that exists between companies by looking at inter-company dynamics (Lovio, 1993). Indeed, Hall (1985) shares several of these views such as close proximity to higher educational establishments and research institutes as helping to catalyze the development of new intensive centres of high technology. Finally, as Hernesniemi et al (1995) argue, while the Porter model has a relevance to the Finnish

experience, it does not fully explain it even if it has been heavily acknowledged by the government in development policy formulation (Hernesniemi et al, 1995).

To be fair, the cluster model developed by Porter concentrated at first on structures at national level and successful industries. Later, however, he extended his analysis to include the notion of clusters within specific geographical areas, laying considerable stress on the role of proximity as an additional dimension (Porter 1998). Similar definitions have been made by other researchers (Swann and Prevezer 1996; Enright, 1996). This approach, however, has received considerable criticism due to its over-general application and rigidity. Despite the criticism, it is widely used as a framework in development policy at a national and regional level. In Porter's cluster, the competitive advantages of industries are drawn from the competitive advantage of companies based on Porter's generic competitive strategies (differentiation, cost leadership and focus strategy) (Porter, 1985). There are other similar ideas which seek to explain regional or industrial district competitveness but these will be dealt with later in the chapter.

Where do Industrial Regions emerge?

In 1985 Hall argued: "*New industries were developed in the regions that differed from the old industrial regions. The vicinity of raw materials was no longer the most important factor during the later cycles, as it was during the former ones. Another factor that was seen to explain industrial development, as a whole was the evolution and dynamics of the old industries – the new emerging areas were not too closely tied to the industrial traditions of the old industries. Although several regions can be seen to have equal opportunities for developing their industrial base, the occurring development seems to be located in an uneven manner. For example, several regions suffered from the decline of population during the 1970s as Silicon Valley started to grow. Silicon Valley was the centre of microprocessors and associated industries in the United States and since 1950 it has been the fastest growing industrial area in the United States*."

In his analysis of the factors that favoured the emergence of new businesses, Hall emphasises the role of R&D activities in universities and research centres. According to him, high technology industries seem to be found near research activities and quite often these centres of research have been established by chance or as part of government policy. For example, Stanford University was started with a donation from Leland Stanford, an entrepreneur in the railway industry, and it was built in a totally rural area (Hall, 1985; Saxenian, 1994). In Great Britain, however, the Cambridge

area was developed in close connection to the university (see also Segal Quince & Partners, 1985) but the development of the M4 Corridor was based on the dense concentration of government scientific establishments in the Reading- Newbury- Oxford triangle (Hall, 1985). Hall points out: "*However, it should be stressed that even after the development process initiated by technological innovations has started, the research centres often continue to play an important role – with the existing parent companies/insitutions – in the emergence of spin-offs. The new emerging spin-off organisations in many cases remain closely related to their parent organisations as they are frequently dependent on the same information and personnel resources. Therefore strong regional rooting and networks can be identified between the companies, research centres and higher education institutions*". Finally, Hall (1985) describes the emergence of high technology centres in this context as perhaps a new version of the Marshallian Districts.

2.1.3 Company growth models, the company and the industry interface

Earlier the chapter analysed several factors behind industrial renewal and presented models of industrial clusters, which combine the development factors both from an industry's and nation's point of view, particularly along the lines of the early Porter model. As noted, this model is considered by some to be rather generalistic and too rigid, but it, nevertheless, provides some understanding of the different factors and their roles in a successful cluster even if it does not cover the creation process of clusters. On a regional level, the role of the industrial companies (both small and big) is crucial in the new industry creation process. To achieve a deeper understanding of the behaviour of established and growing companies, it may well be more valuable to try to explore the reasons for linkages being formed between companies in a region to create new industries and with supporting institutional structures.

Therefore, in the following section, theories explaining the growth models for small and medium-sized companies will be analysed. Certain key theories will be used to demonstrate the growth models of companies and the increasing interaction between the evolving industry and growing companies. In the latter part, attention is paid to the formation of regional clusters and the evolution model for a cluster.

In examining company growth models, Salonen (1995) argues that previous researchers have not presented any common theory or theories, which could be the "*leading*" framework to explain the growth models of small and medium sized companies. According to him, the studies are not directly

comparable with each other; they have different goals, unique empirical populations, and different research problems.

"*The models describe company growth as a predetermined sequential process from one stage to another. In these models there are from three to six different stages for the company growth process. The stages are identified as inception and survival to growth, expansion and maturity. Different stages are characterised by variables such as size, managerial style, organisational structure, formality, strategic goals, and founder involvement* " (Salonen, 1995).

From the many company growth models, which have been developed, probably the best known early ones, Salonen argues, have been presented by Greiner (1972) and Churchill and Lewis (1983). Although there are a number of studies that look at the growth of young technology based companies (like Bullock, 1983; Van de Ven, 1984; Kazanjian, 1988; Kazanjian and Drazin, 1990; Autio 2000), for our immediate purposes the focus will begin with that of Greiner.

Greiner's Growth Model (1972)

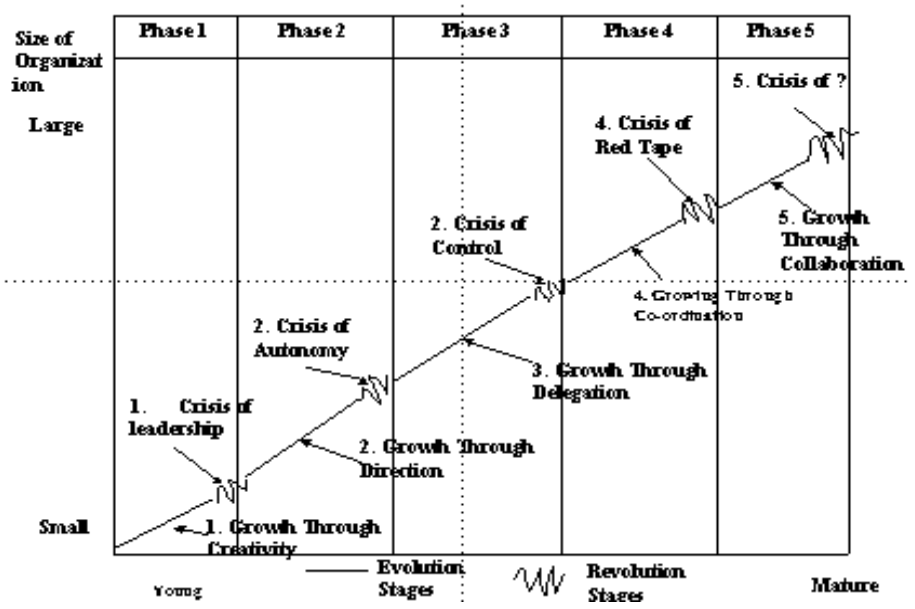
According to Greiner there are five different phases in the company growth process. Every phase forms a relatively stable growth stage, which leads to some kind of crisis or other. The organisational growth phase includes the various stages of evolution and revolution. In the evolution stage, there are no radical organisational changes happening. In the revolutionary stage the organisation faces some incoherence in which structural changes occur. It is also important to emphasise that each phase is both an effect of the previous phase and a cause of the next phase (Greiner, 1972).

In the early phases of Greiner`s model, (See Figure 2.2) the founding owner's creativity plays an important role. The founders typically have a technical background or they are generally entrepreneurially oriented and do not put so much effort into management or leadership activities, a view echoed later by Tidd, Bessant and Pavitt, (2001). In the first phase, the creativity evolution lead to a crisis of leadership. The next evolution period, direction, a functional organisation structure is introduced, accounting systems for inventory and purchasing are introduced and communication becomes more formal. This all leads to an autonomy crisis. The third evolution period is then delegation, and the next crisis, the crisis of control. In the fourth evolution period, co-ordination, the use of formal systems for achieving greater co-ordination increases and the top

executives take more responsibility for the initiation and administration of these systems. The increasing bureaucracy leads to the crisis of Red-Tape.

The next period, collaboration, emphasises greater spontaneity in management actions through teams and the skilful resolution of confrontation of interpersonal differences. Social control and self-discipline take over from formal control and this, he argues, will lead to the evolution of new organisational structures, which allow employees to periodically rest, reflect and revitalise themselves.

Figure 2.2 Greiner's Model of the five stages of growth



Source:Greiner, 1972

According to Greiner, the speed at which the organisation goes through each phase of evolution and revolution is closely related to the market environment of the industry. The evolutionary periods tend to be relatively short in fast-growing industries and longer in mature or slowly growing industries. Evolution can also be prolonged and revolution delayed in the organisation, which makes profits.

The five stages of small business growth (Churchill and Lewis 1983, Scott and Bruce, 1987)

Some eleven years after Greiner's work, Churchill and Lewis revisited the subject matter and found that the models or frameworks developed for examining businesses were inappropriate for small businesses for the following reasons:

1. they assume, that a company must grow and pass through all the stages of development or die in the attempt;
2. the models fail to capture the early stages in a company's origin and growth;
3. the frameworks characterise company size largely in terms of the annual sales (and/or the number of employees) and ignore such other factors as value-added, the number of locations, the complexity of the product line, and the rate of change in products or production technology.

So building on Greiner's earlier work as well as complementing it, Churchill and Lewis developed a five stage framework, (Existence, Survival, Success, Take- Off, and Resource Maturity). Each stage is characterised by size, diversity, and complexity and described by five managerial factors: namely, the managerial style, the organisational structure, extent and formal systems, major strategic goals, and the owner's involvement in the business.

Churchill and Lewis´s stages are laid out as follows, but as argued by them these will vary between firms:

*" **Stage I**: "Existence; The main function of a business is to obtain customers and deliver the product or service on time. The organisation is a simple one, the systems and formal planning are minimal or do not exist. The strategy is simply to stay alive. Essential for success is the owner` s ability to perform, and match business and personal goals. The owner` s ability to delegate is less critical".*

***Stage II**:" Survival; The company has enough customers and keeps them satisfied. Attention is paid more to generating enough cash flow to stay in business and to finance growth in the market share, big enough to guarantee a position in the business. Formal planning is typically cash forecasting."*

***Stage III**: "Success; At this stage the owners facing the decision of expanding the company or keeping the company stable and profitable, whilst providing a base for alternative owner activities.*

A key issue is whether the company is a platform for growth – a substage III-G (Success- Growth)- or do the owners completely or partially disengage from the company- making it a substage III-D (Success- Disengage), company. In the Success- Disengage substage the company is economically healthy. It has sufficient size and product-market penetration to ensure economic success. The company can continue for a long period in this sub-stage. If the company cannot adapt to changing circumstances, it may either fold or drop back to a marginally surviving company. In the Success-Growth substage the company and its management are heading for growth. Systems are installed for the future and the owner is deeply involved in strategic planning. If the company does not succeed in growing, it may shift to III-D stage or Survival stage. Bankruptcy or sale of the company are also possible".

Stage IV: *"Take-off. In this stage, the key problems for the management are, how to grow rapidly and how to finance the growth. For the owner it is important to be able to delegate responsibilities to others to improve the managerial effectiveness in the fast growing and increasingly complex enterprise. The key managers have to be very competent in managing a growing and complex business environment. In the life cycle of a company, this stage is pivotal, if managed successfully; the company can grow into big business."*

Stage V*: "Resource maturity. In this stage there are concerns about how to consolidate and control the financial gains brought on by rapid growth, and to retain the advantage of a small size (flexibility, entrepreneurial spirit). The company now has the advantage of size, financial resources and managerial talent. If the company can preserve the entrepreneurial spirit, it can be a formidable force in the market, if not, it may enter a sixth stage of ossification, which can be characterised by a lack of innovative decisions and avoidance of risks."*

According to Churchill and Lewis, there are eight different factors, which change in importance, as the business grows and develops as shown in Table 2.1.

Table 2.1 Company and Owner´s Related Factors

The Company Related Factors	**Owner Related Factors**
financial resources	owner's goal for himself/herself
personal resources	owner's operational abilities in doing functional jobs
system resources	owner's managerial ability and willingness to delegate responsibility
business resources	owner's strategic abilities

Source: Churchill and Lewis, 1983

Five four later Scott and Bruce's (1987) research found, in their five stages mode, similar development phases and crises, to those of Greiner and Churchill and Lewis. The growth process of a company evolves through different stages, which are: Inception, Survival, Growth, Expansion and Maturity. The Scott and Bruce model differs in that it is linked more to the lifecycle of the business. In each critical development phase the company can go into the growth path or stay at that stage or fold. They also analyse the different factors (such as top management role, stage of industry, organisation structure, management systems, cash flow, etc) and their changing role and content in different stages.

Writing three years later, Kazanjian and Drazin (Kazanjian and Drazin, 1990) used a four stage growth model for technology-based companies as gradually the research became increasing refined and succinct. The four stages, as shown in Table 2.2 are: conception and development, commercialisation, growth and stability. This model was earlier presented in Kazanjian`s study: *"Relation of Dominant Problems to Stages of Growth in Technology Based new ventures"* (1988).

Table 2.2 The company growth model

	Stage 1 Conception and Development	**Stage 2** Commercialisation	**Stage 3** Growth	**Stage 4** Stability
Decision-making Centralisation Formalisation	 high low	 high medium	 medium medium	 low high
Functional specialisation Marketing and sales Manufacturing Engineering	 low low low	 low high high	 high high high	 high high high
Rate of company growth with the above pattern of decision-making and functional specialisation	high	high	high	high
any other pattern	low	low	low	low

Source: Kazanjian and Drazin, 1990

The various growth models presented here do differ in degrees, yet they share a commonality in that they describe growth as a process from stage to stage. Different stages are linked to the organic growth of the company, but also to its acquiring a position in the market (see Autio, 2000). In the fast growing industries, these process stages become faster. Yet Autio is extremely critical of several of the above growth theories in that they fail to lay sufficient emphasis on defining the product market environment. His criticisms also extend to growth models which concentrate on those situations where the market already exists, where the complexity of the market is not examined and where there is no discussion of the correlations between the technology and growth.

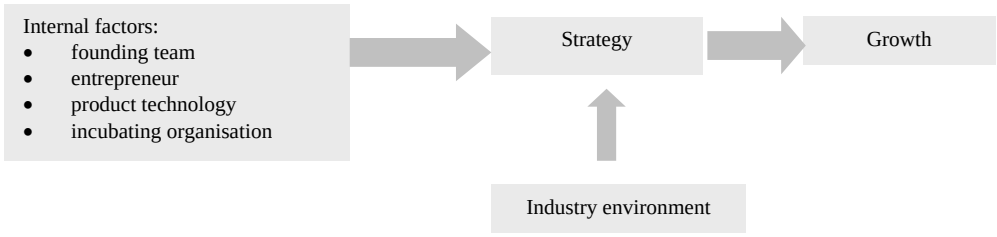
"*We mostly hear stories about successful companies, but little information is as forthcoming from those who fail to crack the market. Yet the road to successful market creation is littered with the bodies of those who failed to make it"* (Autio, 2000)

The Influence of Industry on the Growth of Companies

Important to an understanding of the growth of firms is the role of the industry itself. Sandberg and Hofer (1987) explored this topic in an attempt to link together the growth of companies to the industry to which they belong, particularly in technology based industries. Their findings showed that the key to success was due to internal factors such as the use of resources, entrepreneurship and quality of management, especially in fast growing industries where in line with Greiner's thinking

the speed of change is fast and firms have to respond quickly. This, however, needs to be contextualised within the life cycle of a business, the specific stage of an industry's growth, its structure and overall environment, a verdict upheld by Autio in his work (Autio, 2000). Indeed Sandberg and Hofer offered a strategic model to help explain industrial and firm growth as shown in Figure 2.3

Figure 2.3 Sandberg and Hofer's multilevel framework



Source: Autio, 2000

This model above demonstrates the growth process, in which growth is a result of a strategy combining both the internal factors and the factors created by the industry. In cases, where the industry is just evolving, the strategy process is very complex. When managing company growth and position in the market, the entrepreneurs and management teams face pressure from the competition, in which sustainable competitive advantage provides the future growth (e.g. Ansoff, 1965; Porter, 1985). Any competitive advantage is the result of company specific factors linked to the business and industry to which they belong. In general terms, the distinctive or unique factors for companies can be technical know-how, responsiveness to market needs, financial resources, design and engineering capabilities as espoused by Hamel and Prahalad (1990 and 1994), who have further developed these concepts of core skills and capabilities as a source of competitive advantage in their resourced based view of the firm.

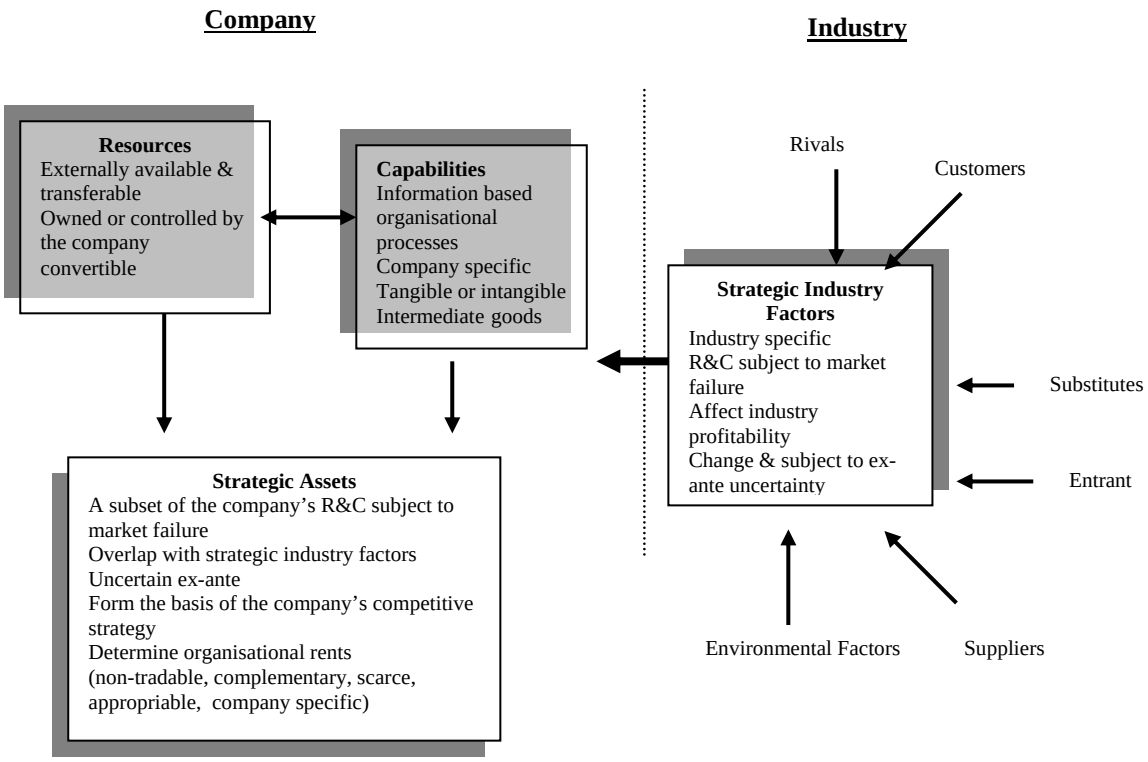
Amit and Shoemaker (1993) also analysed the relations between the industry and the company from the point of view of the company's resources. They argued that a company is a bundle of resources and capabilities, and examined the conditions that contribute to the realisation of sustainable economic rents. They defined the resources as stocks of available factors that are owned or controlled by the company. Resources are then converted into final products or services by using a

wide range of other company assets and bonding mechanisms like technology, management information systems, and incentive systems. They define *"capabilities"* as a company's capacity to deploy resources, usually in combination, with organisational processes, to achieve a specific goal. Amit and Shoemaker's approach, therefore, reviewed the relations between a company and its industry using Strategic Industry Factors and company specific Strategic Assets. However, they pointed out that difficult managerial decisions in companies are made frequently in different sets of circumstances:

- uncertainty: because of economic, industry, regulatory, social and technical environments, the competitors' behaviour and customers' preferences;
- complexity: the interrelated causes that shape the company's environment, the competitive interactions ensuing from differing perceptions about these environments;
- intra-organisational conflicts.

The complexities of relationships, according to Amit and Shoemaker, between the company and the industry are illustrated in Figure 2.4.

Figure 2.4 The company and industry interface



Source: Amit and Shoemaker 1993

The Strategic Industry Factors (SIFs) are determined at market level through the interaction berween the company's competitors, customers, regulators, innovators outside the industry, and other stakeholders (Key Success Factors are similar). The resource-based view of the company manager has a set of resources and capabilities, which evolve in the long run. The success of the company is a result of the Strategic Assets of the company combined with the resources and capabilities which are scarce, durable, not easily traded, and difficult to imitate. The observation at industry level brings success factors, which are anyway general, and do not explain the success of an individual company. The management (or management team) in each company builds its own, unique success factors, which in the long run are based on resources and capabilities. All growth models similarly see growth as a cyclical process, which at an early stage defines the role of entrepreneur, entrepreneurship, creativity and issues related to survival and position in the market. Later on, when the initial problems are over, the role of management, processes and the management of growth become more important.

The model of Amit and Shoemaker emphasises the resources and capabilities, whereas the growth models emphasise more functional growth. When growth is also seen as development in resources and capabilities, this can lead to growth by cooperation and possibly integration through the deepening of business links with other entities rather than of organic individual expansion. Resource expansion on the basis of the core competence model can also lead to further integration with the external environment. Arising from this kind of integration are industrial districts, innovative milieus and regional clusters.

2.1.4 The Evolution of the Regional Cluster

When a new industry begins to evolve from a ”virgin” stage, development can be assumed to be cyclical according to the growth theories. The first challenge for new companies is to survive and find a business strategy (existence, survival and success according to Churchill and Lewis, or creativity and direction according to Greiner). When there are several companies in the same situation in a certain region, a development path can be demonstrated by the evolution of a regional cluster model, which combines both the entrepreneurial aspects of a management mental model. The concept of a regional cluster here means a group of companies in the same industry, having links with each other and with regional institutions such as universities and specialist research centres. The quality of entrepreneurship at an early stage (Low and Abrahamson, 1997) is perhaps an indicator of development potential, and the existence of what might be termed a ‘common management mental model` can influence the behaviour of the management in those companies.

The management mental model is assumed to evolve and lead to a shared perception of the business and environmental culture they are involved in which can also be linked to the resources available.

It has been argued that technological changes are a triggering mechanism for new entrepreneurs in that they can create change or capitalize on innovations elsewhere and internalise them. As Schumpeter argues *"These pioneers remove the obstacles for others..... The first leaders are effective beyond their immediate sphere of action and so the group of entrepreneurs increases still further and the economic system is drawn more rapidly and more completely than would otherwise be the case into the process of technological and commercial reorganisation meaning periods of boom."* (Schumpeter, 1934)

Fast-growing, geographically clustered companies within industries have become an increasingly important part of the competitive landscape. These fast growing clusters are sometimes referred to as hot-spots, which are defined as follows (Pouder and St. John, 1996): hot spots are regional clusters of companies that (a) compete in the same industry, (b) begin as one or several start-up companies that, as a group, grow more rapidly than other industry participants, and (c) have the same or very similar immobile physical resource requirements in the long run.

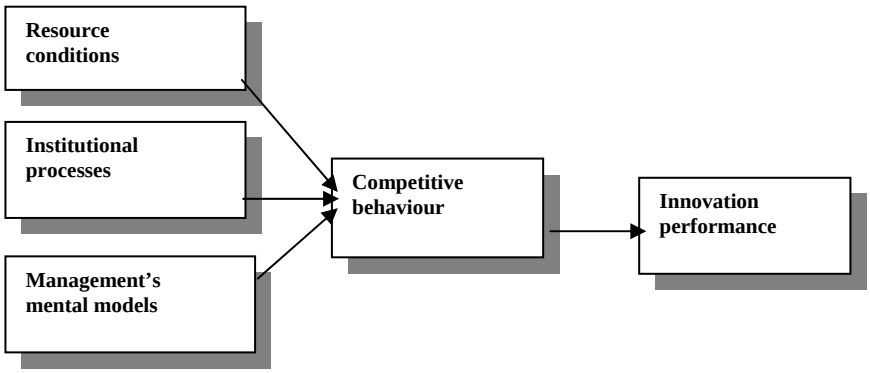
When analysing the processes involved in the development of regional clusters of NTBFs, issues such as path development entrepreneurship, networks, resources, and their role in and relationship to the regional cluster come into focus. This information is needed to understand the entrepreneurial, institutional, and international or global forces affecting the development of fast-growing, innovative regions, and especially of the companies operating in these regions.

The context

Entrepreneurship is one of the key issues in understanding the development of regional clusters (e.g. Keeble, 1989; Oakey and Mukhtar, 1998). Since entrepreneurship can be seen as a context-dependent social process (Low and Abrahamson, 1997), the characteristics of the context become important. One way to define the context is the industry, with the regional cluster viewed as a part of the total population of the industry (Pouder and St. John, 1996). The division between emerging, growing, and mature (or declining) industries applied within entrepreneurship research can be transferred to regions, since not only industries but also regions go through evolutionary phases of development. Pouder and St. John (1996) distinguished three phases in the evolution of clusters –

origination, convergence, reorientation – that resemble phases of industrial evolution. As the industry boundaries continually shift – even faster within the technology-based industries than within the ”traditional” industries due to the emergence of new technologies – it is difficult to define the industry boundaries. The concept of a regional cluster provides a way of resolving this difficulty since the region can be considered an industry (an industrial district) or a part of it. Thus, the boundaries of the industry are defined by the geographical boundaries of the cluster.

Figure 2.5 Forces Affecting the Evolution of Hot Spots



Source: Pouder, St. John, 1996

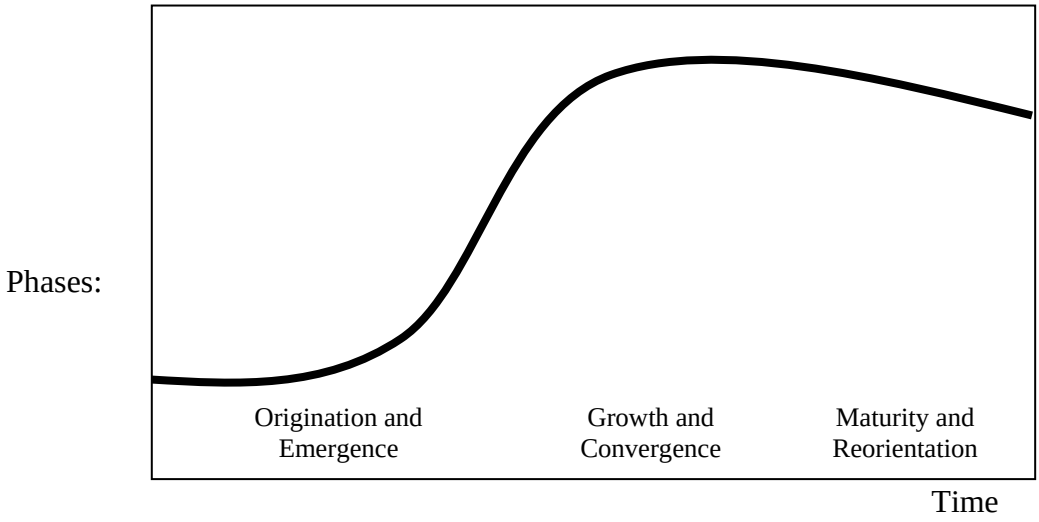
The forces, as shown in Figure 2.5, affecting entrepreneurial behaviour within a regional cluster include (1) the personal networks of the entrepreneurs, (2) the activities of the entrepreneurs, (3) the motivations of the stakeholders of various types, and (4) the structures and strategies of the emerging organisations within their contexts (Low and Abrahamson, 1997). On a regional level, the forces affecting the evolution of the cluster include (1) resource conditions, (2) mental models of management (and entrepreneurs), and (3) institutional processes related to gaining legitimacy for the new companies and technologies in the markets (Lovio, 1993; Pouder and St. John, 1996). In fact, the need for legitimacy is the reason for clustering, since companies participate in inter-company relationships to enhance legitimacy. The typical characteristics of the markets in which NTBFs operate are rapid technological changes as well as technological heterogeneity (Weiss and Heide, 1993), i.e., the absence of dominant technologies. This makes it difficult for the NTBFs to establish the legitimacy and credibility needed to access international markets and networks. Local, regional, and national networks, by contrast, represent an easier environment for NTBFs, since they provide the basis for the initial growth and internationalisation of companies. The local or regional network may provide the companies with skilled staff, needed technologies, and opportunities to

supply other companies with innovative products or advanced, knowledge-intensive services. However, access to international markets is not necessarily supported by the local or regional networks and may necessitate recourse to external assistance.

Phases of Evolution

As shown in Figure 2.6, firms in the regional clustering processes normally proceed through several stages of evolution from origin to maturity.

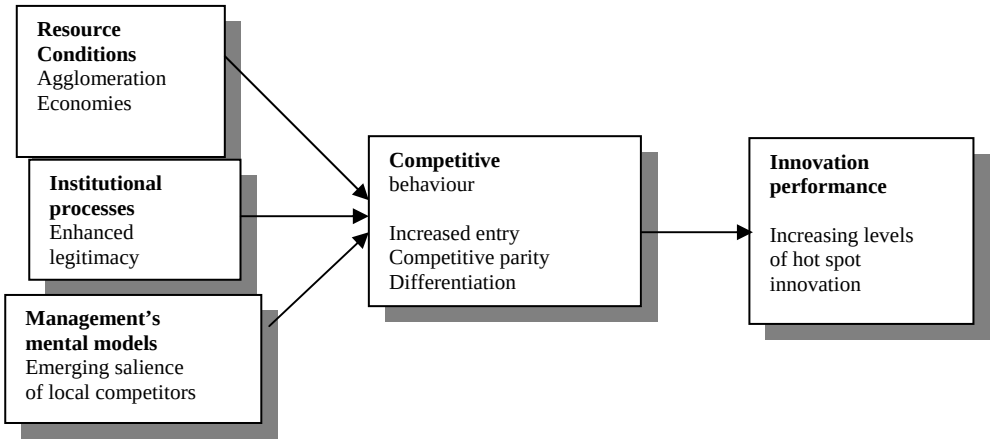
Figure 2.6 Evolution of regional clusters and entrepreneurial activity



Source: Ahokangas et al, 1999

Origination and emergence: as illustrated in Figure 2.7 in the first phase of cluster evolution, innovative entrepreneurs utilise unique personal contacts that enable the linking of previously non-overlapping networks. New, fast-growing companies are founded and problems related to the legitimacy of the new activity must be solved. The structures and strategies of emerging entrepreneurial activity are market-based, with collaborative elements, as externally available resources are actively used by the NTBFs. With new companies entering the emerging cluster, agglomeration economies are achieved eventually. Similar mental models evolve among the entrepreneurs and key personnel of the companies in the region (Pouder and St. John, 1996; Low and Abrahamson, 1997). In addition, competition can be expected to grow as businesses serve the same customers and are in turn served by the same suppliers.

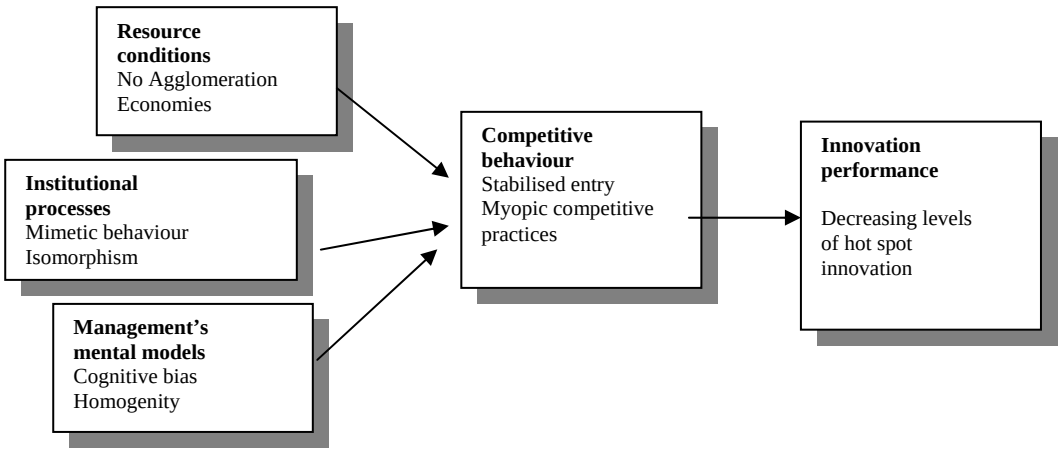
Figure 2.7 Forces Affecting the Evolution of Hot Spots during the Origination Phase



Source: Pouder and St. John, 1996

Growth and convergence: once the problems of legitimacy have been overcome and real growth has begun, (See Figure 2.8) entrepreneurial success rests with the ability to thrive in environments characterised by rapid growth and change. This calls for extensive, high quality networks with relatively weaker ties, as compared to the previous phase of cluster evolution, and more differentiation in business strategy to counter the effects of the converging mental models of entrepreneurs and managers within the cluster, which tend to encourage imitation and homogeneity in business activities (Pouder and St. John, 1996; Low and Abrahamson, 1997). As imitation and homogeneity begin to take hold, the cluster enters the phase of convergence: the growth rate of the companies decreases, as does the number of new entries into the cluster.

Figure 2.8 Forces Affecting the Evolution of Hot Spots during the Convergence Phase



Source: Pouder, St. John, 1996

Maturity and reorientation: in mature environments, increasing competition for resources leads to cost increases, causing the loss of agglomeration economies. At the same time, entrepreneurial activity becomes even more conservative and imitative in nature (Low and Abrahamson, 1997). If agglomeration diseconomies persist simultaneously with increased imitation and homogeneity, reflected in the strengthening and stability of ties between cluster participants, the number of companies within the cluster starts to decrease and innovation starts to occur outside the regional cluster.

Despite the pessimistic determinism of the three-phase evolution described above, the inevitable decline may be avoided or postponed by two forces: internationalisation of networks and deliberate introduction of heterogeneity in the regional cluster and its business activities. Technology-based industries have become increasingly international (Karagozogly and Lindell, 1998), NTBFs are well advised to adopt a multi-domestic or global approach to markets from the very start, or build specialised international networks (Koed Madsen and Servais, 1997; Simmie, 1998) to overcome resource shortages and exploit market opportunities. The process of internationalisation also seems to enhance the evolution of the cluster, since it adds new customer and supplier contacts and introduces diversity and heterogeneity.

2.1.5 New Technology-Based Companies (NTBFs) and regional clustering

The birth and development of new technology-based companies can be depicted as evolutionary, and the entrepreneurial behaviour of individuals plays an important role in that evolution (Ahokangas et al, 1999). The majority of NTBFs are part of a greater value creating system. According to Yli-Renko and Autio systemic evolution has been found to have several phases:
" firstly an NTBF is founded; a new, NTBF is founded as a spin-off or as a private venture to exploit new technological solutions; secondly the NTBF connects to a network or chain: the NTBF develops initial customer and other connections; some of these connections become intensive; the NTBF becomes involved in an innovation network or manufacturing chain; thirdly the cluster develops: positive externalities develop the network; the development and growth starts to feed itself: many NTBFS are founded; the locomotive effect takes place; it locks into a paradigmatic technological stage; the NTBF is manufacturing and/or is technologically embedded and fourthly the NTBF is able to link into other networks and clusters: the NTBF has developed company-specific distinctive competencies; the NTBF reaches a critical mass; it is possible for the NTBF to link into other networks and clusters and become less dependent on the initial cluster" (Yli-Renko and Autio, 1996).

A cluster's development is often driven by a locomotive or anchor company (Yli-Renko and Autio, 1996). The locomotive company both drives and benefits from the technological development in the network and gains competitive advantage. The locomotive company catalyses the growth in the network and can also acquire other companies in the network. Often an NTBF is very dependent on the locomotive company and the network development. At this stage, the NTBF is developing or has developed company-specific competence to create value for its customers in the network. This competence makes the new, technology-based company valuable both to local and, on occasions, to more distant networks.

Although this model gives some descriptions of the technology-cluster emergence and development process, it must be stressed that the evolution is an ongoing process and that NTBFs are born at different stages in the process. Furthermore, there may well be other companies in close proximity, which for one reason or another choose not to join the network, but prefer to stand alone. Finally, as Yli-Renko and Autio (1996) postulate, development is an iterative process:

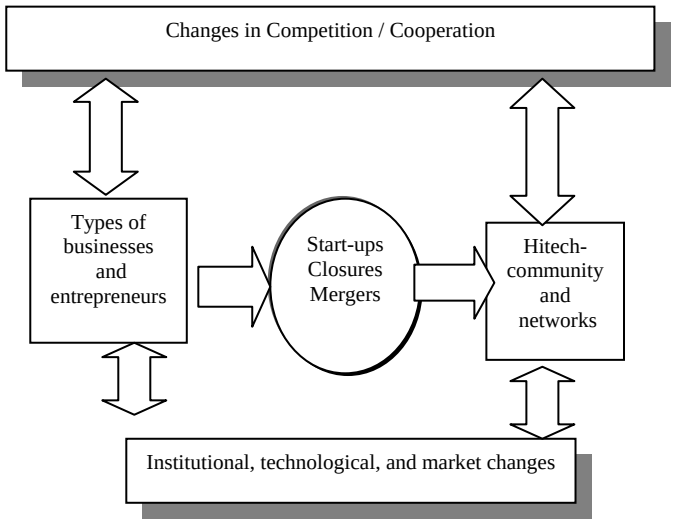
"The systemic evolution is not a linear process: one stage does not necessarily lead to another. The evolution takes place spontaneously, as a result of the actions of the actors in the network. Environmental conditions, such as science and technology policy efforts can affect the evolution process" (Yli-Renko and Autio, 1996).

The linear view of innovation still largely dominates the existing government industrial policy in parts of Europe. However, Quintas et al (1992) in their investigation of industrial policy in the UK have contested this view in their research on science park contexts. Similarly, according to Yli-Renko and Autio, the Finnish governmental policies have been largely designed to catalyse rapid, organic growth in the NTBF and they suggest that the definition of "success" in the context (when focusing on new technology firms) should be broadened from a systemic perspective. Success could equally well be defined to consist of continued technological excellence instead of rapid organic growth. Both the systemic evolution and the hot-spots model of regional clustering, however, point to the changes in the competitive and co-operative behaviour of single companies. This can be seen also as a learning process for firms in understanding the industry in which they operate. Indeed, when this understanding increases, their own capabilities and resources can evolve positively.

2.1.6 The Evolution of a Company Community

Regardless of how clusters evolve and develop physically, Lovio's view (1993) goes further and sees clusters of firms very much in communal social terms and not just as an agglomeration of firms sharing a common interest in the same location (See Figure 2.9) He analysed the Finnish electronics industry from 1920 to 1989 and described the evolutionary development of the industry through a metaphor of the "company community." In his model the company community is described as an ever-changing community of companies undergoing competitive and co-operative activities and processes. Also forces external to the community, such as the growth of other types of and complementary industries, competitive behaviour and structures all affect the development of the whole of the community.

Figure 2.9 Company community



Source: Modified from Lovio, 1993 by Hyry et al, 2001

In Lovio's model, as depicted in Figure 2.9, two institutional factors are emphasised, namely, technological and market change. Changes in the company community take place in three ways : entries/exits, growth, and the acquisition of companies.

In his analysis of the period 1920-1989, Lovio identified three development cycles; cycle I (1920-1959), cycle II (1960-1974), and cycle III (1975-1989). The change of the cycle is determined by technological and market changes; e.g. the latest change (1975) in the study took place when microchips emerged and the Finnish electronics industry started to internationalise. Lovio emphasises the cumulative experiences, which can be seen as the domestic market dominance of old diversified corporations in Finland irrespective of changes in technologies and markets. In fact, many traditional Finnish companies have been able to respond to the changes in the national economy through internal renewal and adaptation. Nokia itself is a good example of this (see Chapter 5).

Lovio also refers to the development of inter-company relationships. According to him, there are three phases in inter-company relationships and their development through the various stages of evolution (see Figure 2.6): legitimisation, competition, and specialisation. At the legitimisation phase the structure of an industry is often fragmented and, therefore, there is no direct rivalry between companies. The competition phase starts as the industry consolidates and fragmentation

diminishes following a shake-out, and technical progress becomes more defined. During this phase and beyond it many firms become more specialised and try to find niches best suited to their products and resource base. This can also encourage inter-firm cooperation through networking, subcontracting and specialisation in research and development. The first two are often the backbone of inter-company networking (Lovio, 1993).

In his conclusions, Lovio states the following*: "The vitality of economic progress, creative destruction and accumulation heavily depend on the diversity of company types and single companies in the economy. A company's success is closely bound to its managers' abilities to identify the main role of the company in the entire company community and to utilise the company's specific resources and accumulated know-how…"*

When comparing the company community model with the regional cluster presented earlier, the company community stays dynamic, through entries, exits, acquisitions and changes in the co-operation and competition, which revise the regional structure. The development stages of legitimisation, competition and specialisation are defined more broadly than those in a regional cluster.

2.2 National and regional initiatives in creating new technology based industries

In the 1960s and 1970s, the national governments in Europe generally became more active in trying to alleviate regional problems through regional subsidies, tax benefits and employment premiums, for example. Economic growth in countries is rarely evenly spread and steps were taken by central governments to reduce regional inequalities. This was especially true in France and the UK, for example, where the Growth Pole Theory was implemented (Perroux, 1971). This refers to the implantation of a key industry in a defined geographical area where it can act as as a propellant to industries already in the area or attract other industries as a magnet and so stimulate economic activity by raising output and incomes. In France, for example, following the publication of Gravier´s work, *Paris et le Desert Francais*, the government targeted Metropoles d` Equilibres in disadvantaged Departments to deal with problems of unemployment, and rural drift especially to Paris. Therefore firms and industries were heavily subsidised to move out of Paris to the provinces which explains why, for example, Citroen was more or less forced to build a new plant in Rennes when the government refused it permission to expand its operations in Paris. Similarly, there was an increase of university places in large regional cities to take the pressure off the higher education institutions in Paris. (Clout, 1976) In the UK a similar policy was implemented, especially in

Scotland through the construction of a new steel mill at Ravenscraig near Glasgow and, for example, the forcing of the Rootes Group - whose application for an Industrial Development Certificate to further develop its Coventry plants was rejected by the government - to open a car plant at Linwood, also near Glasgow, to help offset the decline in employment in the area's traditional industries (Young and Hood, 1977). This type of policy in Finland, it must be stressed was confined primarily to higher education expansion through the foundation and subsequent expansion of both the Oulu University and the University of Lapland and also by the further development of polytechnics in Oulu, Kemi, Raahe and Kuusamo so that Northern Finnish students could benefit from a widening geographical offer of higher education facilities. However, this policy was not avidly pursued in industry except in so far as it was through government initiatives that VTT came to open a facility in Oulu and that Northern Ostrobothnia´s infrastructure – roads and communications etc. - were improved considerably in the 1970s and 1980s. In other words, the central government did make attempts to create a framework in which industry could grow. However, it did not adopt the same attitude to industry as did its French and British counterparts except in the building of the Rautaruukki steel mill in Raahe and the Outokumpu steel mill in Tornio in the 1960s. Furthermore, the identification of the need to create an electronics industry in the Ostrobothnia area, and even then much of the subsequent initiative, came from within the Oulu Region.

In view of the above statement and of subsequent development, it is clear that in Northern Finland a great deal of hope was placed on stimulating local entrepreneurship in the electronics industries and related industries essentially through the setting up of higher education institutions with a specific regional mission to encourage new industrial growth not dependent on indigenous resources, but more on human capital. In view of this, the Science and Technology Parks became crucial factors in the development of technology intensive agglomerations in the region over time, even though this was due to a combination of local initiatives rather than simply central government direction These parks can often be considered as highly influential in the creation process of high technology industries. In the next section, the evolution and development and fluctuating role of Science and Technology Parks in Europe generally are considered, so that Oulu´s experience can be viewed in a wider setting.

In the 1970s, the first Science Parks established in Europe followed the models of the USA. However, it needs to be stressed that there is no definitive model for Science and Technology Parks even if many of them do share several common characteristics such as proximity to higher

education establishments, have limited funding and often enjoy either regional or national governmental support. In addition to these common characteristics, most of the parks represent their national and local cultures and fit into their local environment in their own particular way.

2.2.1 Science / Technology Parks: the American and European Models

In the industrialised countries, there has been an ongoing process, in which the industrial structure has changed at different speeds. The triggering factor in these development stages has mainly been technology, which has changed and is changing the positions in the markets and also the locations of the industry. The technology is changing the game.

The period after World War II was the catalysing factor for the new technology based industrial development in the way it is currently understood. In these development periods, the stories of Silicon Valley and Boston Route 128 are perhaps the best known and also the subjects of most research. The role of the public authorities or government has been crucial in that development. The development of new technology was strongly financed by the federal budget for military, defence, aeronautics and astronautics purposes. Large organisations (like NASA) were also important clients in the development of new technology and new technology based products.

After the Cold War, the federal financing started to decrease and the competence developed by public research turning more and more to business, the role of entrepreneurship started to grow, the number of spin-offs increased, the number of jobs in new technology based companies (NTBF) rose leading to a revolutionary development phase, which has now been identified (Markusen et al, 1986; Saxenian, 1994; Pouder and St John, 1996; Zhang, 2003).

In both of these developments (i.e. Silicon Valley and Route 128), the universities – e.g Stanford and MIT among others - and the research institutes played an important role in creating the basic resources and skills for further development and success. During the first decades of Silicon Valley and Route 128, from the 1940s until the 1960s, the activities were very research-oriented. This period led also to many revolutionary, technological inventions which triggered a new industrial model, known variously as Technology Centres, Technology Parks, Science Parks, Business Parks, Technopolis and so on. One invention, and perhaps the most important of these, was the invention of the transistor which was the first step towards the semiconductor industry, integrated circuits (ICs), mini and microcomputers, the software industry, telecommunications, the internet and so on.

Examples of these kinds of new companies are e.g. Hewlett Packard (1938), Schokley Transistor Company (1955), Texas Instruments, Fairchild Semiconductor (1957), Intel and AMD (spin offs from Fairchild Semiconductor). In the 1960s, Silicon Valley became a centre of computer chipmakers, which gave it its name. The late 1970s and 1980s were the eras when computers (personal workstations) emerged and companies like Apple, Silicon Graphics, and Sun Microsystems soared high. The 1990s were in turn dominated by the Internet and companies like Cisco, Netscape, eBAY and Yahoo were flagships of that decade. Between 1990 – 2000, 29,000 companies were created in the region and in 2001 there were roughly 672,000 employees in those companies (Ablett at al, 1998; Zhang 2003).

Although Silicon Valley, and Route 128, in the Boston area, are presented as the main models for the new technology based industry, there are also other well-known technology centres in the USA, with a long history. For instance, the Research Triangle Park in North Carolina (established in the 1950s) and Austin in Texas are examples of those older ones. The number of Science Parks increased and at the end of the 1960s there were about 50 Science Parks, and at the end of 1970s, about 80 (Vuorinen et al, 1989).

2.2.2 The European Response

In Europe, the first Science Parks were established in the beginning of the 1970s: e.g. Parc International d'Activités de Valbonne Sophia Antipolis (about 1970) in France, the Cambridge Science Park (1973) and the Herriot Science Park (1974, Edinburgh) in the UK (Vuorinen et al, 1989). The first Science Park established in the Northern European Countries was the Technology Park of Oulu (1982), the second was the Ideon in Lund (1983) in Sweden, and in Germany the first was BIG in West Berlin in 1983 (Segal Quince and Partners, 1985; Vuorinen et al,1989).

There were different kinds of policies in each country to promote the Science/ Technology Park concept and its variations.

<u>France:</u>

France has been a leading country in the adoption of the Science/Technology Park concept as a tool for industrial renewal. In the beginning of the 1970s, three technology centres were established: Maylan–Grenoble, Sophia Antipolis and Nancy-Brabois. In the middle of the 1980s, there were

about twenty technology centres already established or under development. The role of central government in this development has been crucial; the aim of financing technology centres was to strengthen technology transfer in order to provide new jobs in new technology based industries. In the beginning, the technology centres were very technology specific, and the focus was to attract big industry to those centres. Not until the middle of the 1980s did the focus shift to attract small and medium sized companies to the centres. The total investment was about Ff 3.3 billion, two-thirds of which was provided by the state from the 1970s until the mid 1980s (Sunman, 1986).

Sophia Antipolis has been one of the successful centres and there are now more than 20,000 jobs there (Albert and Boucant, 1998; Autio, 2000). In France the government and public industrial policies have been the main drivers in creating a nationwide, technologically specialised group of technology centres. Considerable public financing, including funding from both local banks and local authorities, has been the key to building the infrastructure, setting up research activities and also in financing operational costs at the start-up stage. A second French example exists in Grenoble, representing a relevant manifestation of the Triple Helix at work in which the interaction between the university and regional players, such as the local authorities and banks, were instrumental in the establishment of the ZIRST Science Park (Gulbransen, 1997).

The UK

In the UK, the two ways of establishing new technology-based industries were by using regional or national development policies., Some regions were active in this and attracted growing electronic and other industries to set up plants and manufacturing units in their region (e.g. in Scotland, and the M4 Region). This kind of development started in the 1950s. Scotland was particularly successful at this and a large number of jobs were created. However, this did not link up with strong research and development centres, as was the initial idea, rather Scotland remained a place of manufacturing and it suffered from that weakness later on. In the late nineties and early 2000s, a number of firms closed their Scottish manufacturing facilities and moved to cheaper locations elsewhere in Europe.

The first Science Parks in the UK were the Cambridge Science Park and the Heriot-Watt Research Park, both established in 1972. In the 1980s, a Science Park building boom emerged in the UK. At the end of 1988, there were 38 Science Parks, which were employing about 10,000 people. The

biggest ones were in Cambridge, Aston, Southbank and Warwick when ranked by the number of tenants (Quintas et al,1992; Massey et al, 1992).

In the UK, the focus of the industrial policy in promoting Science Parks was to activate and increase the technology transfer from the universities and higher education institutes to high technology companies as a catalyst for industrial renewal (Tikka, 1988; Massey et al, 1992). One reason for the Science Park boom in the UK could also be the cutting of university funding in 1981, when several universities lost around 30 % of their funding (Quintas et al, 1992). In most Science Parks, the universities were involved in the process of organising financing, land, premises and some services. In the UK the concept of financing the Science Parks varied, but the government's and local authorities' share has been the dominant source in most cases (Tikka, 1988). Finally, of all the Science Parks, the park in Cambridge has been the most successful and the number of jobs in Cambridgeshire was approximately 28 000 in 1996 (Garsney et al, 1993; Ablett et al, 1998). Its rival Science Park in Oxford was established in 1991 and the number of jobs in Oxfordshire was approximately 25 500 in 1995 (Lawton Smith, 1998; Garnsey and Lawton Smith, 1998).

Germany and the Nordic Countries

Germany was slow to establish Science and Technology Parks. The first established centre of technology was Berliner Innovation und Grunderzentrum (BIG), which started in 1983 and had links with the Technical University of Berlin. Later on, in the 1980s many similar centres were established all over the country. In Germany, the centres fell into two main categories: centres for innovations and centres for incubation. Most centres were located in old, renovated industrial premises and this also gave them an added role in industrial restructuring (Tikka, 1988) .

The establishment in 1982 of the Oulu Technology Park was the first in the Nordic Countries. The example of Oulu and its subsequent publicity raised the interest of other university cities in Finland to start activities to set up their own versions of the Science/ Technology Park. In Sweden a similar process was happening. In 1988 there were 7 Technology/Science Parks in Finland employing 2,140 people, and in Sweden 11 Technology/ Science Parks employing 4,225 people (Vuorinen et al, 1989). In Norway and in Denmark the development was slower.

2.2.3 Definition of Science / Technology Parks

The definitions used in this context are heterogeneous. The most common terms in English are: Science Park, Technology Park, Research Park, Innovation Park, and Innovation Centre. It is difficult to determine any difference between them. The most common term in the UK seems to be *"the Science Park"*, where the concentration has links to higher educational institutes. The UK Science Park Association (UKSPA) provided the following criteria for a Science Park (1985):

"The Science Park is a property based initiative which:
- has formal operational links with the university or other higher educational or research institutions;
- is designed to encourage the formation and growth of knowledge based businesses and other organisations normally resident on site;
- has a management function which is actively engaged in the transfer of technology and business skills to the organisations on site."

In Finland, the most common term is Technology Park, and all the parks have close links to universities and research institutes. The aims of those parks are to build links between research and industry and offer an attractive environment for high technology companies. Although the common frame is similar for Technology Parks, there are different kinds of formats for the parks. The profiles are strongly linked to the local research institutes, and depend on how the interaction between the institutes and companies facilitates growth and development activities in those areas.

The 1980s was the decade when European countries adopted the model of Science/Technology Park. Each country tailored the model for its own purposes. In the UK, the universities have been playing a key role as in Finland and Sweden, whereas in France the government and public authorities have adopted the Science/ Technology Park as a tool to create national technology and develop innovation policies. In Germany, many parks have focused more on innovation and incubator activities.

By the early 1990s, only a small number of such parks in Europe had succeeded in progressing beyond the initial growth stage. These included Cambridge in UK, Sophia Antipolis in France, Kista in Sweden and Oulu in Finland. There are other parks, which subsequently have been

successful like Oxfordshire, in the late 1990s (Longhi, 1997; Ablett et al, 1998; Albert and Boucand, 1998; Lindelöf and Löfsten, 2001).

An analysis of the Science/Technology Parks is a multidimensional process. The goals for the parks are on different levels: there are regional goals and national goals. The real profile is created and maintained mainly on a regional level, but there are also many national aims as shown in Table 2.3, which illustrates the different target areas and goals for a Technology Park.

Table 2.3 Goals for a Technology Park

Target area	Goal
Science and technology policy	Technology transfer from research units to enterprises and to production
Economic policy	Support in changing economical structures, in creating and encouraging a climate for entrepreneurship
Labour policy	To create new jobs
The tenants	Premises at reasonable prices, some financial support, business consultancy

Source; Friedler and Wotke, 1988

These factors can be considered from a regional or national level and each park has its own variation of those goals. The principal initiative for establishing Science/Technology Parks in Europe has been technology and innovation transfer. There have been many studies from the points of view of technology and innovation about barriers to technology transfer (e.g. Lawton Smith,1996), academic-industry links and innovation (e.g. Quintas et al, 1992) industrial support for high-tech industry (e.g. Lawton Smith 1991,1996,1997,1998; Autio, 1997), comparative studies of NTBFs in Science Parks and Off- parks (Löfsten and Lindelöf, 2001).

2.3 Industrial districts and innovative milieus

In Finland, the cluster-based concept (based on Porter's model) in regional business development has had a prominent (and perhaps dominant) position. Since the late 1990s, however, further research has been carried out by economic geographers such as Martin and Sunley (2003), for example. Their theories concerning the idea of specialized industrial locations are based on Marshall's early twentieth century work, in which he identified local features like skilled labour, the growth of supporting and ancillary trades, and the specialization of different companies in different stages of production, characteristics which also feature in Porter's work nearly a century later.
In the next section, several of these models are discussed.

2.3.1 Industrial Districts

When analysing why certain regions can develop and survive longer than others, Markusen found that the model of Marshallian industrial district and its Italian variant, New Industrial District (NID) could not explain all the sticky places (an area in which growth and development are self-evident through durable companies and employment growth over time). When defining a sticky place, Markusen says a sticky place is "better" if it:

1. ensures average or better-than-average growth of a region as a whole over time;
2. insulates a region from job loss, company failures in short-to-intermediate-term business or political spending cycles;
3. provides relatively good jobs, improves tendencies toward income duality, and prevents undue concentration of wealth and ownership;
4. fosters workers' representation and participation in company decision making; and
5. encourages participation in regional politics.

In her typology Markusen presents four types of new industrial districts as sticky places. These types appear in Table 2.4.

Table 2.4 The types of New Industrial districts

Types of New Industrial Districts	Some typical features;
Marshallian industrial districts and its Italian variant	Business structure dominated by small, locally owned companies Key investment decisions made locally Labour market internal to the district, highly flexible High rates of labour in-migration, lower levels of out-migration Evolution of unique local cultural identity, bonds Workers committed to districts, rather than to companies
Hub-and-spoke district	Business structures dominated by one or several large, vertically integrated companies surrounded by suppliers Core companies embedded non-locally, with substantial links to suppliers and competitors outside the district Key investment decisions made locally, but spread out globally Long-term contracts and commitments with the dominant companies and suppliers High degree of co-operation Labour market internal to the district, less flexible Workers committed to large companies first, then to district, then to small companies Evolution of unique local cultural identity, bonds High rates of labour in-migration, but less out-immigration Long-term prospects for growth dependent upon prospects for the industry and strategies of dominant companies
Satellite industrial platform	Business structure dominated by large, externally owned and headquartered companies Key investment decisions made externally Absence of long-term commitments to suppliers locally Workers committed to the company rather than the district Little evolution of unique local cultural identity, bonds
State-anchored industrial district	Business structure dominated by one or several large, government institutions such as military bases, state or national capitals, large public universities, surrounded by suppliers and customers Workers committed to large institutions first, then to the district, then to small companies

Source: Markusen, 1996

There is some debate about which of the two terms, regional cluster or industrial district, is the more accurate. Unlike Markusen, Simmie and Sennet (1999) prefer to use the term regional cluster, rather than industrial district. Nevertheless, the degree of similarlity between them is such that, as Männistö (2002) says, it is difficult to differentiate between them.

The concept of industrial districts in their different forms describes distinct industrial structures in certain regions. The common factor for these kinds of regions is a relatively long industrial history, as a result of which local advantages have developed which are unique and not easy to copy. The dominant factor can be a network of local SMEs (typical in Northern Italy) or network(s) of successful SMEs supporting some bigger company or companies (hub-and-spoke). The satellite

types of regions can be typified as an effective production place and a good example for state-anchored industrial districts, as were Silicon Valley and Route 128 in their early stages.

Looking at the typical features of each type of district, the long history in the development of an industrial district can be identified. Local factors like, the local flexible labour market, evolution of the local unique cultural identity, long-term contracts, high-rate labour in-migration, are signs of the local spirit or entrepreneurial atmosphere, which are behind the success. There are many similarities between the diamond model (Porter 1990) and the industrial districts. Both emphasise the structure of companies, the structure of certain industry and the local factors supporting or empowering the industrial growth or development. The industrial district model points more to the role of local factors, whereas Porter's diamond model points more to the roles of infrastructures, domestic markets and other national factors. Both modes of analysis give a perception of the structure and factors explaining development, but the question of how and why this happens has to be answered locally. Finally, Piore and Sabel (1984) emphasise the importance of permanent innovativeness in the ongoing growth of industrial districts. According to them, the industrial district can be kept as a social and economic entity, which is able to secure the balance in competition and cooperation and also adopt new innovations and technologies.

2.3.2 Innovative Milieu

The concept of innovative milieu was originally developed by the GREMI group (see e.g. Aydalat and Keeble, 1988; Camagni, 1991). The concept refers to the development of the business and economy of a region not only dependent on the success and failure of individual businesses, but more importantly, on the co-operation of the different business actors in the region which were seen as a crucial element for economic renewal. Indeed, co-operation was considered as a basis in this process of renewal (Camagni, 1991). The background to the concept of innovative milieu consists of theories and concepts developed in the 1970s and 1980s (Camagni, 1995). These include the concept of an industrial district, the concept of local context and the concept of local production systems. In the concept of innovative milieu, special attention is paid to company-company interaction and to the capacity of the environment to maintain and enhance this interaction process. Thus, the process includes the whole "socio-economic process" of the region, e.g. labour markets as well as their ability to remain a competitive "local production fabric" (Camagni, 1995). Within an innovative milieu the production fabric consists of flexible small and medium-sized companies. The basic difference between the earlier theories of regional development and the innovative milieu is

the fact that, in the latter, the innovation processes of the region are seen as important determinants of the efficiency of regional economy. The efficiency of the innovation processes becomes visible in regional abilities to develop and utilise innovations and new technologies, to react to changes and to reallocate resources from stagnating to emerging sectors. Thus, the concept of the innovative milieu can be defined (Camagni, 1995) as follows:

"Innovative milieu is a set of relationships that occur within a given geographical area that bring unity to a production system, economic actors, and an industrial culture, that generate a localised dynamic process of collective learning and that act as an uncertainty-reducing mechanism in the innovation process."

The position of different players as part of an innovative milieu-network can be defined by the indicators "*centrality*" and "*density*" (Bramanti and Maggioni, 1997). The term centrality can be further defined by using three indicators, degree, closeness and betweenness and is presented in Table 2.5.

Table 2.5 The three indicators of centrality

Centrality	
Degree	Describes the number of those network partners to whom all network parties are connected, thus, a high degree indicates intensive exchange relationship of a central player with numerous other actors
Closeness	Represents the independence of an actor with respect to the influences of other network partners. It also describes the ability of an actor to communicate in the network
Betweenness	Implies the ability to control and co-ordinate processes within the network and to maintain mutual communication

Source: Freeman, 1979

High levels of centrality indicate the existence of a hierarchical network whereas low centrality can be described as a situation in which there is parity in the distribution of power, which indicates that the position of an individual network member may vary. The "density" of the network is defined as the ratio between the total amount of existing links or connections and the maximum number that they can assume in a network of given dimensions (Bramanti and Maggioni, 1997, Stenberg and Stenke, 1999).

Within networks there is the issue of Governance between the participating firms. Governance structures can be categorised as: all ring, no core structure, core-ring, with a co-ordinating company and core-ring, with a lead company

"All ring, no core structure is a network without systematic leadership; leadership can be changed according to the situation. In this kind of network there is low hierarchy and equal distribution of power. Actors are independent but committed to the network. The level of betweenness is low.

Core-ring, with a co-ordinating company: the co-ordinating company has a central position in the network; it can affect the activities of other partners with the condition that it is also dependent on them too.

The co-ordinating company has more power than the others, but it is by no means a sole dictator of the network. The role of the network is strategic co-operation, and discussions in the network tend to become formal. The level of closeness is low whereas the level of betweenness becomes higher. The co-ordinating company has extensive contacts outside the region and its role in maintaining the innovative milieu is important.

Core-ring, with a lead company: the co-ordinating company is not dependent on the other companies of the network and it has the possibility to restructure its network. The distribution of power is thus asymmetric, the structure is hierarchical and the activities in the network are formal" (Storper and Harrison, 1991).

Of the four models described above the last is the most relevant in the Oulu situation and this is primarily due the role played by Nokia in the 1990s. This topic will be explored more fully in Chapter six in discussion of Nokia's role as an anchor firm in relation to with his partner firms.

The innovative milieu concept explains local competitive advantage through a regional innovation process. The driving force in this is the industry, the networks of companies. This way of analysing a region, which consists of different networks and also wider social system, comes close to that of the regional cluster and its evolution and the community company models.

At the end of the 1990s, the innovation systems have come side by side with the cluster based approach in research (Männistö, 2002). The innovation system means the unit consists of actors,

relations and processes in order to bring, distribute and use useful information (Lundvall, 1995; Kautonen et al, 2000).

2.3.3 Networking in Developing Regional Business

Both the New Industrial districts and Innovative Milieu emphasise the role of cooperation between companies and use the term, networking. A further contribution in this debate is the Triple Helix Model (Etzkowitz and Leyderstorff, 1997 and 2000; Etzkowitz, 2004). This theory argues that regional development and inter-firm networking can be facilitated by the degree of cooperation that exists between, government, academia and entrepreneurs. In such cases the focus can often be within a specific geogrpahical and cultural locality and on a particular group of firms or industrial sector in which both institutions such as universities and the public authorities assume an active entrepreneurial role than one of passivity as proved to be the case in Oulu when Technopolis was formed in 1982.

Business networks are complex coalitions of business relationships where different counterparts of individual relationships and networks actively communicate with each other (Gummesson, 2000). Each network is unique and results from the uniqueness of each individual relationship and the unique combination of the number of relationships in each network. Cunningham and Culligan (1988) discuss the concept of business networks by dividing them into smaller entities i.e. focal nets. Focal nets consist of a set of the most important relationships for an individual company at any point in time. Counterparts of such nets are not permanent, nor is the relative closeness of the portfolio of relations within the net. Furthermore, a set of focal nets defines the total network i.e. a business network. Companies in business networks are at the same time both objects and subjects of change. Networks have no clear boundaries nor centre nor apex. Networks can be considered organisations in terms of the movement of activities, resources, and actors between the different counterparts (Håkansson and Snehota, 1995). In every network, however, there is a power structure where counterparts have different powers to act and to affect the others in the network (Håkansson and Johanson, 1988). Business nets should lead to a Value net which is a digitally linked network of customer-supplier relationships that creates value for all of its counterparts. It is a business design using a digital supply chain for customer satisfaction and company profitability whereas responsibilities for each activity are given to those who perform it best. Information flow plays an integral role within the network – especially as the Internet and e-commerce facilitate business design (Bovet and Martha, 2000A; Bovet and Martha, 2000B).

Social network analysis is a loose collection of methods that can be used to illustrate the multitude of social structures, connections, relationships and dependencies between social phenomena. On the one hand, it is sometimes regarded as a new sociological paradigm (e.g. Burt, 1982; Berkowitz, 1982) that combines social action theory with the sociological tradition of Talcott Parsons (e.g. Johansson et al, 1995). On the other hand, it can also be seen as being limited to specific quantitative or qualitative methods and tools that can be used for social research purposes. According to Granovetter (1985, 1992), the recognition of social relationships is necessary, as individual behavior cannot be isolated from its social environment. Coleman's (1990) theory of social action also claims that an individual's behavior can only be understood in the context of the surrounding social relationships. The former is very important because personal relations cannot be isolated from business decisions.

Networks are important regardless of the industry or the size of the companies involved. However, the significance of networks for smaller companies may be far-reaching because of their limited resources. Among others, Carson et al (1995) have identified the concept of Personal Contact Network (PCN). They describe PCN as having a range of different guises, stretching from its density to its diversity, the psychological and geographical distances between its members, and its uniqueness to an individual entrepreneur. They also emphasize the informality of these networks.

Social networking can be seen, therefore, as co-operation, which is wider than simple business-based networking. The aim of such co-operation is to strengthen the business environment and in that way strengthen the competitiveness of individual companies. An example of social networking or interaction is the informal social atmosphere in Silicon Valley, which allows the exchange of knowledge and innovation (Saxenian, 1994). This works like an "invisible engine", fostering the diffusion of innovations and the rotation of experts between the companies and research institutes. Developing this kind of unique entrepreneurial culture takes time, and forms a unique process.

Now that the appropriate literature has been reviwed to contextualise the remainder of this study, it is time to proceed to a discussion of the research methodologies to be used in the subsequent analysis.

2.4 Conclusions

The industrial development of a region can be analysed using different kinds of approaches. According to Kontradieff, Schumpeter and Mensch industrial development is cyclical. The

development of technology leads to innovations, which change industries, industrial structures and also the regions' positions as industrial centres. A good example of this kind of new industry is the invention of semiconductors leading to a revolutionary development in the electronics industry and to Silicon Valley as a leading concentration of high technology enterprises.

The models of industrial districts review industrialised regions by giving cross-sectional models of the structures in each district and they identify the typical features of these districts. The districts are created in a unique way; the environment and its history determine the local culture, which supports the survival of companies and industries in the region. In those districts, the balance between dominant and small companies is changing and the structure is a result of that balance. Industrial clusters, both nationwide and regional, demonstrate cross-sectional structures and conditions in each structures, like industrial districts. The problem in both is the lack of understanding of the creation process of the district or cluster. All the creation processes behind these concentrations are unique, although there may be similar ideas behind the activation of these processes. One method in the last decades has been the setting up of Technology and/or Science Parks. A key issue in these concepts has been the notion of the spin off effect for research institutes. When trying to identify this process more precisely, Etzkowitz and Leydestorff developed the Triple Helix Model (Etzkowitz and Leydestorff, 1997 and 2000), which demonstrates the interaction between academia, industry and government at national and regional levels. Indeed, this model can provide an understanding of clusters or industrial districts on a local level by describing the local operational culture, and how things happen.

In an attempt to demonstrate the birth and development of a local industrial agglomeration (or cluster), which is the aim of this study, it is essential to understand the process from the companies' point of view: i.e. which forces cause new companies to be established, to grow, to create regional clusters, to interact with the local environment and grow out of the region. When these kinds of questions can be answered, it is then possible to demonstrate the growth process. These include the external forces outside the companies, and also the forces inside the companies, and the environment-related forces.

One of the key determinants in this kind of process is the nature of the phenomenon; all is time dependent, cyclical; the industries change cyclically (stress from outside), the companies grow cyclically (stress both from inside and outside), the industrial structures change cyclically (product cycles, profit cycles and so on).

The Science and Technology Parks have arisen as a new tool in the re-industrialising process in Europe, on a small scale in the 1970s and on a bigger scale in the 1980s. The national mission for these parks varies in each country; some are very centrally controlled and some others are more local initiatives. The parks have been seen as a catalyst for a new kind of industrial model which emphasises the role of research, innovation and technology transfer when creating competitive new technology based industry based on local strengths. The Science and Technology Parks are not entities, which can be studied as separate phenomena; they are linked to the industrial society around them and promote the industrial development by creating new local strengths.

Table 2.6 is a conclusive review of the theories and models analysed in this chapter. The theories and models are projected on two levels, the company level and the regional or societal level. The aim is to highlight the differences in the goals, when making strategic decisions and also deciding many common interests.

Table 2.6 Summary of the theories and models considered on company and regional/ societal levels.

The theories and models	Company level	Regional/ Societal level
Long cycles	Product life cycles New options for development	New options for development caused by technology and innovations Regional advantages changing Instability Competition between regions Co- operation between regions Restructuring
Science Parks Technology Parks	Resources for research and development Premises, consultancy, financial support Special services New entrepreneurial options Local climate Examples, behavioural models	Local or national initiatives Technology, innovation transfer Changing economical structures Encouraging climate for entrepreneurship New jobs New image, position in regional competition
Company growth models	The resources and abilities available in companies defines the growth Growth from stage to stage such as conception, existence,commercialisation, growth, stability Managerial ability crucial	Regional SME policy and support
The evolution of regional cluster	The cyclical evolution Origins and emergence Growth and convergence Maturity and reorientation Cumulative experience in some areas Shared expertise and managerial mental models	Regional life cycles Dominating mental models Changes in the entrepreneurial activities Blind spots may occur Resource conditions changing Agglomeration of economies
The firm community	Strategic behaviour of companies Competition/ co-operation Dynamic factor Entries/ exits Growth Acquisitions Growth rate	Strategic behaviour of companies Competition/ co-operation Dynamic factor in community Entries/ exits Growth Acquisitions Growth rate Chances in competitive circumstances and structure (the regions competitiveness) Technical chances Market changes
Industrial cluster	Access into national or international cluster The development stage of the cluster The global competitiveness of the cluster Distinct, company specific factors	Regions' position in the existing or originating clusters The evolution of distinct, regional specific factors The role of developed factors like: human resources knowledge infrastructure Position in regional competition
Industrial districts	Local specific industrial structure dominated by flexible smes or by bigger companies or state anchored institutions Stabilised business models Long term competitiveness Production efficiency Cumulative experience Shared expertise	Special local factors like: Industrial structure Flexible labour market Co-operation between different actors Result of industrial evolution on the region, long region-specific roots
Innovative milieu	Belonging to local network or networks sharing expertise in order to maintain and develop the competitive advantage in their value chain	The presence of formal or informal networks in the region taking care of the competitiveness in the " local production fabric"

Regional industrial development can be a result of indigenous companies, which can create the basis for the phenomenon, and/or the result of decisions made in bigger companies or government institutes starting new activities in a region. National or local initiatives can also support this

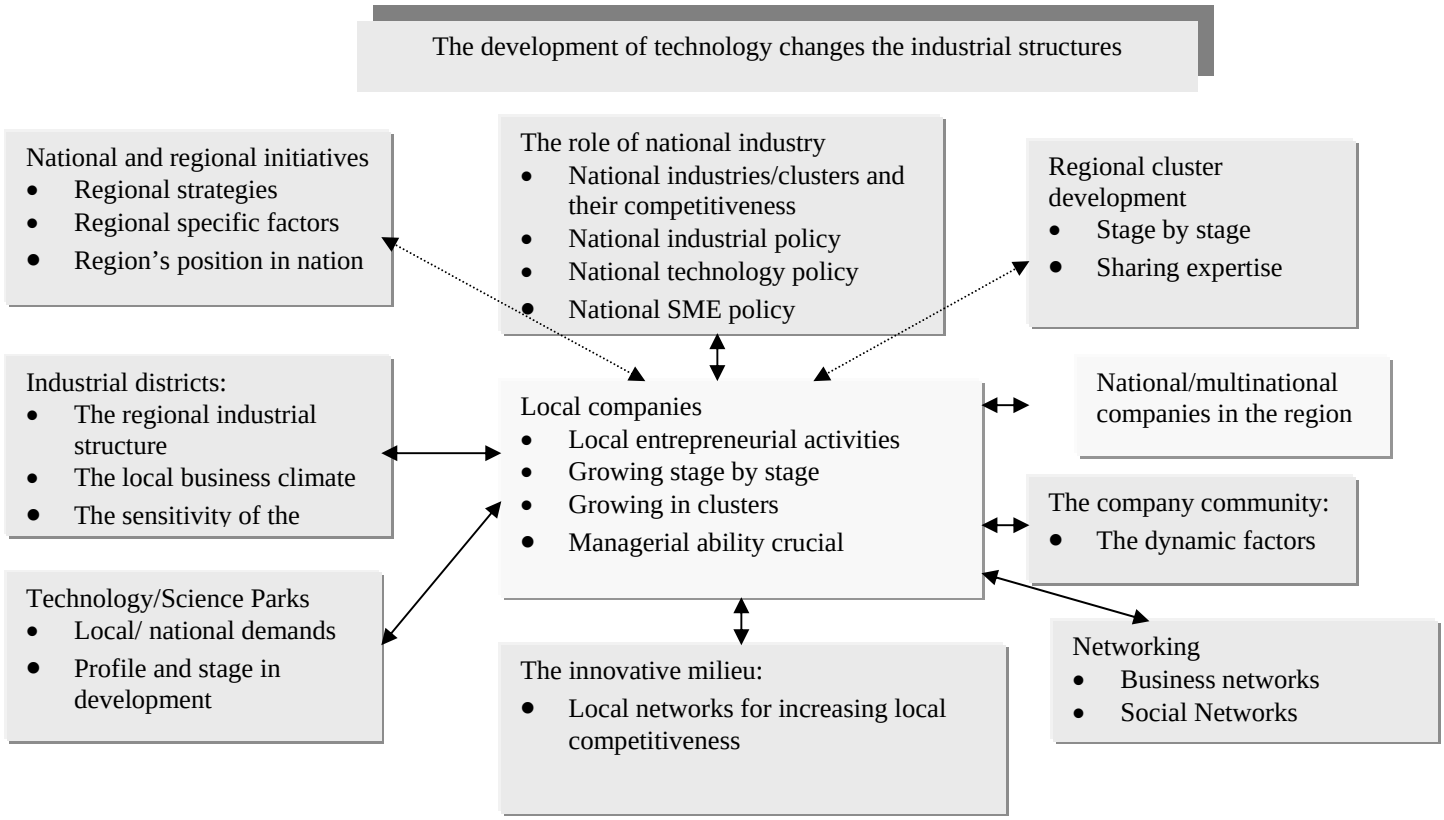
development. The development can be revolutionary, as in Silicon Valley, as a result of a technological breakthrough in semiconductors, or less revolutionary as in most technology-intensive regions. One of the basic beliefs in analysing technology intensive regions is that technology and innovation transfer from the universities and research institutes is a key issue for creating a solid base for technology development. Considerable research has been carried out on this topic (like Kautonen and Kolehmainen, 2001; Kautonen and Tiainen, 2000; Lundvall, 1995 and 1999: Lundvall and Borras 1997).

The technology and innovation transfer can also be determined in a local context by using the Triple Helix model (Mode 3, an overlapping model), which identifies the common areas of interests from the points of view of academia, industry and government. In the longer run, it is essential to mark the changes in the overlapping, and understand the reasons for each of the counterparts' involvement in this co-operation. From the companies' point of view, this kind of co-operation can increase the company specific resources and capabilities inside the shared notion of the strategic industry factors (Amit and Shoemaker, 1993). The universities and reseach institutes are the links to achieve that. This can also be explained by the cluster model, where the focus is more on companies and industries.

Figure 2.10 outlines the business context of a technology intensive region and shows that Oulu's NTBFs were at the heart of this and were the key actors within it. Economic growth and development does not take place in isolation and the figure is also illustrative of the links formed between the NTBFs and the various institutions and bodies that influenced development and thus promoted an entrepreneurial climate from which Northern Ostrobothnia's High Tech Cluster evolved.

During the local industrial evolution, the environment close to these companies changed partly due to the regional clustering and partly due to the national and global clustering. When NTFBs face growth in stages, some of the companies can benefit from the changing local environment and change their business concept to better match the local needs.

Figure 2.10 The Context of High Technology Firms in the Oulu Area



Source: Author

In this study, the main purpose is to understand the regional industrial process of evolution leading to the establishment and development of a regional agglomeration of high technology companies and industries. The focal points are the companies, company creation and their growth and also the new industries set up by bigger companies and their changing strategic behaviour during the period of observation. Regional clustering can be assumed to take place internally within the area, but it can also be influenced and strengthened by an influx of firms from outside its geographical boundaries.

The main theories in this research which explain the growth of the firms are the company growth theories (e.g. Greiner, 1972; Churchill and Lewis, 1983; Scott and Bruce, 1987; Kazanjian and Drazin, 1990) strategy formation (e.g. Sandberg and Hofer, 1987; Amit and Shoemaker, 1993), the evolution of regional cluster and the role of NTBFs in clusters and clustering (e.g. Lovio, 1993,; Pouder, St. John, 1996; Yli-Renko and Autio, 1996; Low and Abrahamson, 1997), industial clusters, concentrations and the role of co-operation (e.g. Porter, 1990; Hernesniemi et al, 1995; Hall, 1985; Etzkowitz and Leydestorff, 1997 and 2000). The abovementioned theories are of

fundamental importance for understanding the relationship between the Research Aim (see Table 3.3) at Levels 1 and 2 and the questions being answered in the empirical part of the thesis.

On closer examination of the behaviour of local technology intensive companies using the regional clustering theories, different stages in the development process can be identified. In each of the stages, the regional industrial structure projects the situation, and links to the relevant theories can be made. The theories explaining the successful industrial regions (e.g. The types of New Industrial Districts and Innovative Milieu) are useful when trying to demonstrate the structural evolution of the region and particularly the changing role of the dominant firms, which is Nokia in this case study (the Aim and Research Questions at Level 3, see Tables 3.3 and 3.4).
At the end of the 1990s the Oulu Region was one of the leading technology concentrations in Finland, and an example of a regional cluster. But the question arises, whether it is possible to trace the clustering process/evolution and does the successful cluster cover all, or whether there are different clusters or groups of firms.

Table 2.7 The importance of the theories

The theories and models	Importance in this research
	Very important
Company growth models The evolution of regional cluster	Provides an understanding of the growth and clustering from the firms' point of view - covers all the development stages - explains strategic formation and evolution process
The firm community	Provides an understanding of the dynamic factors in regional clustering process
Industrial cluster	Demonstrates Nokia's increasing influence in the regional industrial environment and regional clustering since the mid 1980s
	Important
Long cycles	Provides an understanding of the new industrial options in the early 1970s and uncertainty of the early 2000s
Science Parks Technology Parks	Demonstrates models for evolution of new technology industry
Industrial districts Triple Helix Innovative milieu	Results of long term development, important in the conclusive stage of the research

Finally, the central hypothesis being tested in this thesis is that industrial and technological development in Northern Ostrobothnia was dependent upon the role of central and local government, institutional support provided by the university and VTT, the evolution of relevant expertise in human capital in high technology and parallel growth in local entrepreneurship.

3 Research Methods

INTRODUCTION

In this chapter the aim and the objectives of this research, the value of this research, the research strategy and the methods, and how this research was carried out are discussed. At the start of the chapter some relevant contextual factors are presented. These reflect the main factors of the research problem and also the contribution of this research with respect to other similar research. In the latter part of this chapter, different approaches are presented for defining the research strategy, the methods and how the data was gathered.

This research examines the Oulu Phenomenon between 1970 and 2002. These events changed the industrial structure in the region very dramatically, converting it into leading centres of technology in Finland. The definitions, which are relevant to the topic of research and which have now become commonly used in industrial policies, are: technology centres, science parks, technology parks, business parks, enterprise parks. The basic meaning of these different terms is a concentration of new enterprises located in the same area, although there are some differences in status. The term used in Oulu at first was “the Technology Park” but changed later to “Technopolis”. In the UK the common term seems to be “Science Park”, and there the concentrations frequently have links to higher educational institutes.

The Oulu Region is the Finnish trailblazer in high technology, which in this context can be defined as new technology based on electronics, leading to the growth of sectors such as telecommunications, software and biotechnology. The first, preliminary activities leading to the Oulu Phenomenon started approximately at the same time as the first European centres, Cambridge and Sophia Antipolis in the 1970s. The Technology Park of Oulu did not became a reality until 1982. The development of the Oulu Region into one of the leading concentrations of technology in Finland has taken place over a period of some thirty years. At the time of writing this thesis, there are between 10,000 - 11,000 jobs in technology based firms, which is more than half of all the industrial jobs and 10 % of the total number of jobs in the Oulu Region.

This development may be considered the result of several factors. The founding of the University of Oulu in 1959 created the preconditions for the development of know-how and a know-how

intensive industry. The collaboration between local companies, the University and the Local Authorities led to the birth of the first Technology Park in the Nordic countries in the year 1982. Since then the Technology Park has grown rapidly in terms of premises, occupants, and jobs. This development took place without any strong industrial tradition in the region – although an old tradition in trade and commerce was part of the history of Oulu - and without any public financial support in the early stages. In the case of Oulu, small and medium-sized enterprises have played a central role; about two-fifths of all jobs in new technology are created in SMEs (Ahokangas and Räsänen, 1998). Geographically, the Oulu Region offers a well-defined environment for research in the development of technologically oriented entrepreneurship, and new regional agglomerations.

As discussed later here and in Chapter 4 (The Oulu Phenomenon), growth and development has occurred in different stages and in each of the stages the dominant paradigms, main actors and their roles and other conditions have changed. In the early stages of the phenomenon there may have been some influence from the developments taking place in Silicon Valley and Scotland, but in the latter stages the phenomenon has forged a route of its own, the story of its development is not the same as the stories of its European counterparts.

The development has occurred in different stages. These will now be examined in greater detail. There were four main identifiable stages of development during the period 1970 – 2002: the Formative Stage, approximately from 1970 until the beginning of the 1980s, the Consolidation Stage of the phenomenon lasting through the 1980s, the Fast Growth Stage during the 1990s and the Diversification Stage from 2000 onwards.

The Formative Stage 1970-1980

At this initial stage new technology-based industry was considered an option for creating new jobs in Northern Finland. In this stage, it will become evident that the university was the main catalyst. At that time, the fledgling electro-technical industry in the area was beginning to manifest signs of growth and new investments in the region to create a new industrial paradigm. At that stage, public and private attitudes towards such change was ambivalent, but gradually the idea of change took hold when it was realised that the regional economy had to diversify or else it would be in danger of falling into decline. The theories presented in Chapter 2 do not cover all of these issues because much of the process that occurred took place through the form of social interaction between the various interested parties which gradually created an atmosphere of optimism about what might be

achieved through industrial diversification. This stage indicates to some extent the setting of the ground rules and the readiness of the region's authorities and entrepreneurs to move to the next development stage (Rostow, 1960).

The Consolidation Stage 1980 -1990

After almost ten years of pioneer work, the authorities in the city of Oulu woke up to the options offered by the new technology based industries. This led very quickly to the activities discussed in more detail in Chapter 4 in the foundation of the Technology Park and the subsequent launching of the City of Technology campaign. As a result many new companies were set up and the fruits of the pioneer work became more visible. The 1980s can be seen as an era of small, indigenous, technology based firms. The atmosphere at that time was very optimistic and Tunkelo (1988) argued in his study that something "phenomenal" was happening. The paradigm was that the future development would be predicted on these firms. This creation- process of the companies was not speeded up by the activities of the university or any other institution, government or otherwise. It was due mainly to market forces. The new firms faced the same managerial challenges as small firms anywhere. From a management point of view, the NTBFs in Northern Finland had perhaps a particular difficulty in getting their product to market because of their somewhat isolated geographical position.

The evolution of the regional clusters from a theoretical point of view demonstrates how in some regions the growth firms can behave and start to build regional common features to develop their business performance. When creating regional clusters, the Company Community Model (Lovio, 1993), and the later version of that (Figure 2.9), offers tools for analysing the development process from the NTBF point of view.

The Fast Growth Stage 1990-2000

In the 1990s the Oulu Region faced quite a new situation due to fast moving changes in the information and communication technologies, which started to expand and create new markets across the globe. In this development process, Oulu is one of the three main regions in Finland where this kind of development took place. Such was the pace of change that a demand arose for highly skilled labour and, due to its academic profile, Oulu was well placed to meet the changing demand for advanced skills and remain competitive in this sector. Much of this was assisted by the

willingness of the higher education institutions in the Oulu area to adapt its offer to meet the demands of local industry. Indeed, Oulu and its Phenomenon became almost a "national brand" in this kind of regional development. This "brand" has been described as an informal co-operation between different actors, fast reaction and response to the rising needs, fast growth in the number of new jobs, and courage in decision-making (Lundgren and Ylinenpää, 1998; Männistö, 2002).

It is obvious that during the 1990s, the development in the Oulu Region was influenced strongly by the evolving ICT industry in Finland and also globally. Cluster theory provides the necessary theoretical background, but the story behind the cluster evolution is probably more relevant. There has been strong criticism of Porter's cluster because of the generality of its concepts and also because it does not demonstrate the growth process of a cluster and confines itself to merely reviewing existing ones. In this study it is possible to highlight this kind of development process from one region's point of view.

The Diversification Stage 2000 -

The first years of the 2000s revealed a period of fast growth in the whole Oulu Phenomenon, when the development became more fluid due to the global situation in the ICT industry. This was partly explained by the changes in the strategy of the dominant firms in Northern Ostrobothnia as they diversified to meet changing circumstances. As the core competencies developed, the industrial structures also evolved. Manufacturing on a larger scale moved to the areas of lower cost such as Estonia, Eastern Europe and China, and also to be closer to those markets. In the early stages of the Oulu Phenomenon, the leading paradigm was the creation of manufacturing jobs in Northern Finland but by the turn of the century manufacturing was beginning to shift away, leaving the region increasingly dependent on its research and development activities.

The Oulu Phenomenon has happened in a region where there was no high technology industry at all and where the university was established only recently. When compared to the industrial restructuring and changes in the national industrial development policy in Finland since the late 1980s, the Oulu Region has been some years ahead of the rest. The development of a new technology based industry in the Oulu Region gathered force at the beginning of the 1990s, when the rest of the Finnish economy was in recession. This regional success provoked increasing interest in the development model which achieved a majority of the new jobs in technology based firms. This acted as a spur to central government which, using Oulu as a model, initiated the national

Centre of Expertise Programme in the middle of the 1990s in the hope of stimulating comparable developments elsewhere. Later on, this programme led to the formation of the nationwide Centre of Regional Development Programme launched in Finland in the year 2001 by the Ministry of the Interior.

Although the Oulu Phenomenon and the Technology Park of Oulu (later Technopolis Oyj) are widely known in Finland and the phenomenon has been presented and reviewed in many national and international newspapers, there has been no research into the phenomenon in its entirety covering the all development stages of it. All the published documents have focused on just some parts of it. Only a few studies exist on certain sections of the development in the region (e.g. Tunkelo, 1988; Koistinen, 1999; Männistö, 2001; Äikäs, 2001).

The early stages of development of the Oulu Phenomenon were influenced by the examples from Scotland and to some extent from the USA. The dominant thinking at that stage was that the electronics industry was emerging very fast and some of the manufacturing could relocate to Northern Finland and provide jobs for the female population. The thinking behind this was that the male population at that time could still find employment in traditional industries even if these were lowly paid. However, these activities did not lead to the desired results and the development proceeded differently, it became clear that the activities were moving towards new, indigenous companies based on new technology developments beyond the traditional industries.

3.1 How the Oulu Phenomenon can add to the understanding of technology based centres

The development in Silicon Valley over the last six decades is in terms of scale something quite unique, and in this research it will be considered as the main example for technology and science centres today but not used as an object for comparative analysis. The European centres (Cambridge and Sophia Antipolis) compare more favourably in age and size with the Oulu experience, but again as the respective development paths in each of the centres have been unique no comparisons will be made save for illustrative purposes. The Oulu Phenomenon has its own distinctive characters as follows, it:

- is taking place in a region without traditions for a new technology based industry;
- is the first Technology Park/Centre in Finland and the Nordic Countries;
- has gone through different stages and become successful in the 1990s;

- is economically important for the welfare of Northern Finland;
- has initiated and managed to grow without any significant public subsidies or funding;
- has had a changing role of different actors in each of the stages; and
- is an example of a new kind of development policy in Finland from the second half of the 1990s.

In this research the Oulu Phenomenon is examined in a longitudinal way covering the period from 1970 – 2002 and provides a comprehensive picture of its evolution by identifying the crucial elements in each of the development stages. This study also discusses how the development of the Oulu Region can be studied in line with the theories presented in the Literature Review. Finally, prior to discussing the research questions individually, there is a general discussion of how the various strands of the Literature Review have helped to define the relevant research questions.

The Author's Relationship with the Oulu Phenomenon

The author of this text has had the opportunity to follow this development through his own work without being involved too closely in the actual measures and realisation of the policies.

During the early stages of the Oulu Phenomenon (since the middle of the 1970s), the author was working in regional development activities in the Regional Office of the Ministry of Trade and Industry in Oulu. In that period it was possible to develop the skills needed for analysing firms and their managerial and other development needs and also to build relationships with the managers and key people in those companies, both at time of the company foundation and during its subsequent development.

In 1989 the author changed jobs and began working in Oulu University where he was responsible for establishing, developing and managing management training programmes at university level. These programmes (Executive MBA, University of Oulu) have been and are still focused primarily on the increasing need to develop managerial issues in the technology based, growing companies. The main themes in those programmes are Strategic Management and its application to technology oriented companies. In these programmes the author has been working very closely with a large number of the managers and key people in those firms and organisations.This has been a unique position from which to observe the new technology based companies and also the evolution in the

industrial development strategy in the Oulu Region since the early 1990s, when the regional development policy was becoming more cluster and technology oriented.

Since the beginning of the 1990s, the author has been involved in the Oulu Business Review project. The aim of this project was to develop an advanced tool to evaluate and anticipate regional development in the main industrial fields. *The Oulu Business Review* is a major source of information in this research when analysing the development in the 1990s and it is discussed in more detail later in this chapter. The *Review* has been in existence for over 10 years now and the author is a member of the editorial team.

Towards the close of the 1990s, the author was working on various projects, aimed at developing the "next step" of the Oulu Phenomenon towards the sub-regions (From Oulu Phenomenon into Northern Ostrobothnia Phenomenon). The main problem was that the R&D was heavily concentrated in Oulu, with manufacturing being mainly in the south. While initially wishing to change this situation, it was later realised that more could be done to increase development in the eastern and northern parts of the region.

3.2 The research strategy and methodology

Scientific criteria for the research:

When creating scientific knowledge, a researcher has to bear in mind the following criteria with regard to that knowledge: justify, communicate, generalise, state the truth and rebuild (Uusitalo, 1991). More precisely this means:

- the knowledge is justified and the research methods are relevant;
- professional and ordinary people are able to understand it;
- the created knowledge is universally applicable, not very fragmented;
- the researcher tells the research methods, results and also the uncertainties;
- when the science progresses, the results of the study should not immediately disprove but define and lead to rebuilding inside the science.

In doing research it is essential that the research problem and the researcher's skills and competence to do the research match. The researcher is looking for the answers to the question or to the problem from his or her own cumulative experience and experience plays an important role when setting the research question or problem. Gummesson (1993) uses the term "Verstehen" or pre-understanding.

This means that the researcher has first a notion of the problem and its dependencies through his or her experience and the framework for the research is built on that. Remenyi et al (1998) point out the importance of considered reflection before selecting the appropriate research strategy and methods.

3.2.1 From Research Question or Problem to Research Strategy

The purpose of this study is to analyse the development path of a centre of technology (Oulu Region and the Oulu Phenomenon) and also to review the changing role and strategic behaviour of NTBFs in this process, where the business environment has changed rapidly. The study will be longitudinal covering the period from 1970 until 2002.

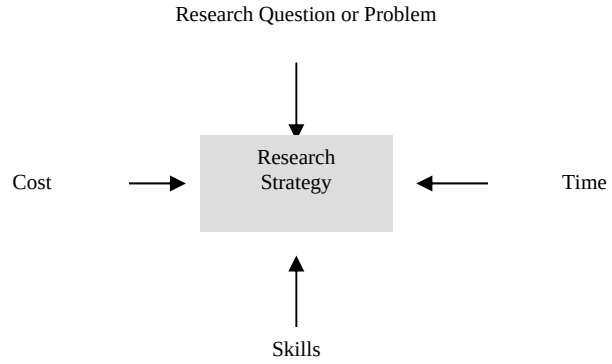
The Research Strategy to answer the above is defined in Figure 3.1 as follows: "*The Research Strategy describes the unity of the methods, which are used to conduct the research or study* " (Hirsijärvi et al, 1997*)*. The process from the research question or problem to the research tactics is described by Remenyi et al. as follows

Figure 3.1 The Research Process

Source: Remenyi et al, 1998

According to Remenyi et al (1998) there are four issues, which affect the Research Strategy. The issues are the research question (most important), the cost or budget available to the researcher, the time available and skills of the researcher.

Figure 3.2 The four issues affecting the research strategy



Source: Remenyi et al, 1998

When defining the research strategy it is essential for the researcher to analyse his or her own expertise and abilities, the resources available and the time limits against the research question; how it is possible to give answers to those question(s) or problems.

Traditionally used research strategies are (Hirsijärvi et al, 1997; Remeneyi et al, 1998, Gummeson, 1993) quantitative and qualitative research. Quantitative strategy has historical roots in natural sciences (physics, chemistry), whereas qualitative methods are more common in younger sciences where the human aspect, and the behaviour of human beings are essential.

Quantitative strategy (also positivism, experimental, hypothetic-deductive strategy) points out the cause and effect (what is happening and why) whereas the qualitative strategy (hermeneutic, phenomenology) concentrates more on explaining real life (why and how). Qualitative research is becoming more common in management studies (Gummeson, 1993) In qualitative research, the role of the researcher is different to the one involved in quantitative research. In qualitative research the researcher and the research question or problem interact very closely and intertwine (see Table 3.1).

Table 3.1 The Key Features of the positivist and the phenomenological paradigms

	Positivist Paradigm	Phenomenological Paradigm
Basic beliefs	World is external and objective Observer is independent Science is value- free	World is socially constructed and subjective Observer is part of what is observed Science is driven by human interest
Researcher should:	Focus on facts Look for causality and fundamental laws Reduce phenomena to simplest elements Formulate and test hypotheses	Focus on meanings Try to understand what is happening Look at totality of each situation Develop ideas through induction from evidence
Preferred methods:	Operationalise concepts so they can be measured Take large samples Use multiple methods to establish different views of phenomena	Small samples investigated in depth or over time

Source: Easterby- Smith et al, 1994

Although the quantitative and qualitative methods are often presented as separate, they are different approaches, which complement each other rather than compete against each other. Here the approach is primarily qualitative as discussed below.

3.2.2 How to select the appropriate research strategy

After deciding the first question - whether quantitative or qualitative - there are several ways of conducting the research. In this selection process, the purpose of the study, research question, research strategy and the way of collecting the evidence are in close interaction. In Table 3.2 this whole field is presented.

Table 3.2 Matching the research question with the research strategy

Purpose of the study	Research question	Research strategy	Evidence collection
Exploratory: To investigate little understood phenomena; identify important variables and generate hypotheses for further research	What is happening in this social programme? What are the salient themes, patterns, categories in participants meaning structures? How are patterns linked with one another?	Case study Field Study	Participant observation In- depth interviewing Elite interviewing
Explanatory: To explain the forces causing the phenomenon in question; identify plausible causal networks shaping the phenomenon	What events, beliefs, attitudes, policies are shaping this phenomenon? How do these interact to result in the phenomenon?	Multi- site case study History Field Study Ethnography	Participant observation In- depth interviewing Survey questionnaire Document analysis
Descriptive: To document the phenomenon of interest	What are the salient behaviours, events, beliefs, attitudes, structures, processes occurring in this phenomenon	Field study Case study Ethnography	Participant observation In- depth interviewing Survey questionnaire Document analysis
Predictive: To predict the outcomes of the phenomenon; to forecast the events and behaviours resulting from the phenomenon	What will occur as a result of this phenomenon Who will be affected and in which ways?	Experiment Quasi-experiment	Survey questionnaire (large sample) Kinesics/proxemics Content analysis

Source: Marshall and Rossman, 1995

Also, Yin (Yin 1994) presents similar ways of doing social science research. According to Yin there are peculiar advantages and disadvantages in each strategy depending on three conditions: the type of research question, the control the investigator has over the actual behavioral events and the focus on contemporary as opposed to historical phenomena.

In choosing the appropriate research strategy there is no hierarchy between these (Yin, 1994). There is no one right research strategy for each purpose of the study. As in Table 3.2 the same research strategy can match several purposes of the study as there can be the same purpose for several strategies.

In this study the research will be conducted at three levels; the first level analyses the Oulu Phenomenon generally in context, the second level investigates in more detail the dynamic elements

of the phenomenon and the third level, analyses and reviews the development against the key theories. The study is formulated so that the final result will be a concept, which will lead to a better understanding of the dynamic factors in regional development in a case such as Oulu.

In this study the research will be conducted on three levels; the first level analyses the Oulu Phenomenon generally in context, the second level investigates the dynamic elements of the phenomenon in more detail, and the third level analyses and reviews the development against the key theories. The study is formulated so that the final result is a concept, which leads to a better understanding of the dynamic factors in regional development in a case such as Oulu.

The aim of this research is presented on page 15 and is summarized in Table 3.3.

Table 3.3 The aims of the research at different levels of the research

	Aims of the Study
Level 1	Analyse the birth and the growth of technology based industries in the Oulu Region, so as to understand the Oulu Phenomenon in its context, 1970 –2002
Level 2	Analyse and understand the dynamics of the technology-based industrial region, especially from the point of view of new, technology based firms (NTBF) and demonstrate the changing role of different technological and industrial groups
Level 3	Conceptualise the technologically oriented region (such as Oulu Region) and its future prospects against the current theories

Source: Author

In a wider perspective, this research demonstrates the shift in the industrial paradigm of Northern Finland from traditional industries (strongly linked to the raw material available in the region) to knowledge and technology intensive industries, where the resources are an educated workforce and research. The initial explanation of this paradigm shift (why it was taking place and how it was anchored in the social situation and dominant actors) is demonstrated in Table 1.1 (page 31). Table 1.1 also illustrates that the paradigm shift is assumed to occur in different stages. When the aims of this research (Table 3.3) are projected against the initial understanding of the Oulu Phenomenon (Table 1.1), it is clear that the dimension of time should be included when translating the aims of the research into questions to be answered.

The aim at Level 1 in Table 3.3 includes the main elements of Table 1.1 (such as the situation in Finland, Northern Finland and the Oulu Region, the leading paradigms, its evolution and dominant actors and their changing role during time).

The Aim at Level 2 in Table 3.3 demonstrates how the new paradigm became visible, then accepted, and how the industrial development and growth in the new technology base firms really happened in the Oulu Region.

The Aim at Level 3 in Table 3.3 is more conclusive, including the questions, how can it be conceptualised and what happened in the high technology industries in the Oulu Region against the current theories.

Translating the aim of the research into questions at each level was a process, on the one hand strongly influenced by the pre-understanding of the Oulu Phenomenon due to the experience of the author and, on the other hand, about how the abovementioned main theories demonstrated the critical issues of industrial growth and development. From the theories, particularly the company growth theories and the theories demonstrating the evolution of regional clusters and the role of NTBFs in those were the most important and they had an influence in forming the questions at Level 2 (Table 3.4). The theories of long cycles (Kondratief, Schumpeter, Mensch and Hall), the theories of science and technology parks and the industrial cluster model (e.g Porter, 1990; Hernesniemi et al, 1995) catalysed the questions at Level 1, which also in this research demonstrates the local industrial environment and its changes. The theories of industrial districts, innovative milieus and triple helix are models for conceptualising the industrial evolution in this research.

In Table 3.4 the aims of each of the stages and levels are changed into equivalent questions. This table comprehensively reviews the study and the links between the different columns in the table.

Table 3.4 Questions arising from the aims of the research

	The Formative Stage 1970-	**The Consolidation Stage** 1980 -	**The Fast Growth Stage** 1990-
Level 1	How the general opinion in the region turned towards a new industrial paradigm Which factors in the regional and national environments were catalysts in the process	How the new paradigm was adopted How different industries progressed How Nokia and its role changes Which factors in the regional and national environments were catalysts in the process	How the cluster-based development was implemented How Nokia and its role changed Which factors in the regional and national environments were catalysts in the process
Level 2	What is the company creation process and dynamics How NTBFs emerged	The role of NTBFs in the region How NTBFs grew How the clustering evolved	The changing role of NTBFs in "hot spots" and the emergence of networking The sectoral shift within the Oulu Phenomenon
Level 3			How to conceptualise the Oulu Region and its future prospects against the current theories

Source: Author

When comparing the purpose of the study and the questions posed for the purpose in Table 3.4, the main characteristic of this study is to be explanatory and descriptive. The phenomenon to be considered is widely known, although the Oulu Phenomenon is not so well-known. The predictive character is created to analyse and understand the technology intensive region, and its future prospects. In this research the explanatory approach is dominant.

The recommended possible research strategies in this context are those of the longitudinal case study or field study. According to Yin (Yin, 1994) the historical case study is most favoured in this kind of study.

According to Gummesson (1993), case study research is becoming increasingly accepted as a scientific tool in management and business administration. According to Yin (Yin, 1994) a case study contributes uniquely to our knowledge of individual, organizational, social, and political phenomena. Yin refers to the use of the case study approach when investigating the structure of a given industry, or the economy of a city or a region. A key point in the case study approach is its relatavity to other examples or cases elsewhere (Morris, 1998). Compared with experiments and surveys, however, the case study as a research strategy is open to criticism. There are several reasons for that. One is as Yin says; "*Too many times, the case study investigator has been sloppy*

and has allowed equivocal evidence or biased views to influence the direction of findings and conclusions," but on this occasion every effort has been made to avoid this weakness.

In this research the author has had a unique position in relation to the aim of the research or research question to be answered from the early days of studying electronics in the Department of Electrical Engineering in the late 1960s and early 1970s (under the guidance of Professors Oksman, Otala and Säynäjäkangas, and others), through the 1980s working closely with the NTBFs in financing investments and development projects in those firms, and on through the 1990s in developing and managing new Executive MBA programmes for managers in those firms and research institutes. During the work it was possible for the author to monitor very closely the main events of the new technology development, partly through participating in some processes (e.g. in financial decision making and as a member of the corporate club, the Northern Lights Association) and also by organising processes (such as the Executive MBA programmes), which created new regional development activities, as demonstrated later in the Chapter 4 (e.g. the Business Development Strategy in 1993 and subsequent technology oriented forums). Although the observation period in this research is extensive, 32 years, the author has been a participating observer in many of those events. This kind of experience supports the case study research strategy (Yin 1994).

The methods used to collect the evidence were documentation, archived records, interviews, direct observation, participant observation, and physical artefacts (Yin 1994). Although the use of specific questionnaires is missing from this list, much of the information that would have been gained from using one has already been culled through the surveys in the *Oulu Business Review*.

The Strengths and Weaknesses of the Sources of Evidence used are discussed in Table 3.5.

Table 3.5 Six sources of Evidence: Strengths and Weaknesses.

Source of Evidence	Strengths	Weaknesses
Documentation	stable- can be reviewed repeatedly unobtrusive- not created as a result of case study exact- contains exact names, references, and details of an event broad coverage- long span of time, many events, and many settings	retrievability- can be low biased selectivity, if collection is incomplete reporting bias- reflects (unknown) bias of author access- may be deliberately blocked
Archival Records	(same as above plus) precise and quantitative	(same as above plus) accessibility due to privacy reasons
Interviews	targeted- focuses directly on case study topic insightful- provides perceived causal interfaces	bias due to poorly constructed questions response bias inaccuracies due to poor recall reflexivity- interviewee gives what interviewer wants to hear
Direct Observations	reality- covers event in real time contextual- covers context of event	time- consuming selectivity- unless broad coverage reflexivity- event may proceed differently because it is being observed cost- hors needed by human observer
Participant Observation	(same as above for direct observations) insightful into interpersonal behaviours and motives	(same as above for direct observations) bias due to investigators manipulation on events
Physical Artefacts	Insightful into cultural features Insightful into technical operations	selectivity availability

Source: Yin, 1994

3.2.3 The Research Strategy

When the aim of this research is converted into questions to be answered, the majority of the questions start with 'how' and 'what kind'. These questions prefer strategies like: multi- site case studies, case studies, history, field studies and ethnography. In this context the case study and history sound very similar, but from the point of view of history the period, 30 years, is quite short. When analysing the academic-industry links and innovations in British Science Parks in 1992, Quintas et al (1992) wrote: *"Final evaluation of the success of science parks in growing significant corporations will only be possible when 15 or 20 years have elapsed"*.

The Oulu Phenomenon is just coming of age, where the Technology Park is 20 years old, and the whole phenomenon is about 30 years old. Its development path is unique and the perception is that it has been successful. From the research strategies, the choice of a case study seems the most appropriate for this purpose. The case study approach in this research supports the

importance of the topic as the Oulu Region has become between 1970 – 2002 an excellent symbol for an industrial paradigm shift catalysing in the 1990s in a new kind of industrial development policy in Finland (as demonstrated in the Chapter 1), and a thorough study of the phenomenon has not been done before and because of the researcher's personal involvement in the events over a long time provided a stimulus for him to carry out the investigation. Despite the extensive aspect of the study, it covers only part of the explanation of the Oulu Phenomenon based on the aim of the study, selected theories, research strategy and resources available. There are paths still open for further research as mentioned in the final chapter. This case study will be both descriptive and explanatory and uses both quantitative and qualitative methods in collecting information. The focus in this research is in the Oulu case, Oulu Phenomenon, and it is not seeked to generalise from this particular case.

The definition of the case

The case in this research is the Oulu Phenomenon. The Oulu Phenomenon covers the industrial development in the Oulu Region from 1970 – 2002 leading to the creation and growth of a new technology based industrial centre. The approach for analysing this phenomenon is based on an understanding of the strategic behaviour of both the firms and the regional business strategy formation. The region is considered as a business environment, which enables and encourages company formation and growth based on the new technology. The case describes this industrialisation process and the changes in a longitudinal way.

Research Plan

The plan to conduct this study is divided into three different parts. The aim of this study and also the questions to be answered, are presented in Tables 3.3 and 3.4. The following Chapters 4, 5 and 6 present the empirical results, and answers to the research questions, and in Chapter 7 the conclusions are made along with recommendations for future research projects

Although the aims and questions are presented on certain levels (levels 1-3), it does not mean that these are separate aims nor answered separately. All three levels of the work interact with each other. Firstly there is the analysis of the course of the phenomenon itself, what happened, why it happened and how it evolved. Secondly, there is a study of the the evolving industrial structure, and

thirdly, both are put in the same framework in order to demonstrate the holistic nature of the process.

3.2.4 Methods and sources used to answer the research questions

When the case study is the research strategy, the recommended methods for collecting information are participant observation, in-depth interviewing, survey questionnaires and document analysis (Yin, 1994). When these recommendations are applied to the main issues of the research strategy (see Figure 3.2), the question becomes: what methods are possible for the researcher in view of the limitations in skills, time and financial resources?

For the author, all the methods, presented earlier, are to some extent available. The methods used in this research are presented in Table 3.6 below, with comments on each of the sources.

Table 3.6 List of the Sources of Evidence used in this Research

Sources of Evidence	**Source Details**	**Value to this research**
Participant Observation	In the early 1970s: the author studied electronics in the University of Oulu	Third level education in electronics
	From the mid 1970s until late 1980s: the author worked for Ministry of Trade and Industry	Expertise in analysis of firms Understanding of the problems of growing NTBFs and knowing the key people
	Since the late 1980s: Working for the University of Oulu, long-term involvement in the development of managerial skills in NTBFs Observing closely the regional *"business driven"* development strategy process Member of the Northern Lights Association of Entrepreneurs Working closely with the Regional Development Council of Northern Ostrobothnia and the Office of Business Affairs of the City of Oulu	Understanding of the evolution of NTBFs in uncertain conditions and strong growth stage Personal links Access to unique events
Survey questionnaire	Oulu Business Review since 1992 (OBR)	OBR has reviewed the developments of NTBFs in each of the main sectors since 1992 Reliable Comprehensive Cumulative Primary material for the author

In- depth interviewing	Interviews (detailed in Table 3.7) -3 interviewees from public sector -5 interviewees from industries	 Provide understanding of the critical issues from the public sectors point of view Provide further understanding of the developments in the telecommunications industry in the Oulu Region Provide *"inside"* understanding of Nokia´s growth and changes in the Oulu Region
Document analysis	Spatial planning documents The Business Development Strategy of the Oulu Region, 1993 Annual Reports (Nokia, Technopolis, VTT, Infotech, Biocenter, PKC Group, Scanfil) Histories (Nokia Oyj, Kajaani Oy, University of Oulu) Other research on Nokia Cases written by the University of Oulu	Covers the whole period, provides documentary evidence Documentary evidence gives examples of the real co-operation which lead to concepts of technological forums Documentary evidence A wider understanding and documentary evidence Provides a wider understanding of the whole company and its strategic changes nationally and globally Examples for the empirical part
Statistics	Statistics Finland Tekes Ministry of Labour	Used to illustrate the main figures from Northern Finland, Northern Ostrobothnia and Oulu Region
Newspaper articles www documents	Full list presented on pages 105-106	Complements material on various topics
Specific material from the interviewees	Research co-operation between the university and telecommunications industry, Nokia´s changing policy in the Oulu Region	Very important in conceptualising the telecommunications industry group

Participant observation

In this research the participant observation has had a significant role. The author's position, although it can be defined as participant observation, has not been directly linked to focal events in this development, rather it can be described as catalysing certain processes so as to understand how these processes work. This participant observation has been particularly appropriate for acquiring an understanding of the industrialisation process in the last three decades. In the last decade, the area has been particularly successful and Oulu and the Region of Oulu have acquired a strong image as leading high technology concentrations in Finland and also in the Nordic countries. It is possible

also to argue, that this "*short term*" success can obscure the observation of less fast growth development stages or industrial groups. In this research the close observation also facilitated better access to this industrialisation process in the early 1990s when the Oulu Business Review was established. The opportunities and problems of the participant observation are demonstrated later in the chapter.

Survey Questionnaire, the Oulu Business Review

A major source of information on the regional development since 1991 is the Oulu Business Review, which facilitates discussion of the industrial structure in particular of the Fast Growth Stage. The Oulu Business Review began as a twice year questionnaire- based survey conducted by the University of Oulu since 1992, but since 2000 has been reduced to a once a year exercise.

When the city of Oulu, through its department of industrial affairs, started to develop the regional business strategy based on technologies (= technology clusters) in the early 1990s, there was an increasing need to know more about the situation in each of the main industries in the region. This was the initiative which led to the development of the Business Review of Oulu Region (later OBR) as a tool tailored for local needs. The tool was developed in the Oulu University in close co-operation with the local firms such as the Northern Lights Group, which helped to finance the launch of the OBR and which retains membership of the editorial team alongside representatives of the City of Oulu. In the University of Oulu, the author was in charge of the editorial work. The first step in this development work was to create reliable links with the firms wanting to participate in this process. This was done initially by interviewing 65 firms or business units located at that time in the region. This sample was estimated to represent more than 90% of all the production in high technology firms. These interviews were then transcribed into reports, which were the initial approach. The reports represented the situation in 1991 and also analysed the origins of the firms and provided the first method for analysing the industrial structure in Oulu Region.

As a tool of analysis, the OBR was further developed in 1992 and has since functioned as a structured questionnaire twice yearly. The city of Oulu has ordered this publication and the University of Oulu has produced it, and the author has been responsible for conducting the surveys and publishing the results. The first versions of the OBR covered the high technology industry, but when Finland went into a financial recession in 1993, the OBR was extended to cover other

industries and business services and the number of firms or units surveyed grew to approximately 400.

For the purposes of this thesis, the OBR is primary material. The author has access to this, and also knows the limitations of its usage. The data in the OBR covers the high technology firms and units which have five or more employees and can be defined as production firms; the local service firms are excluded. The database is updated every year by using the information from publically available statistics on the Finnish economy as well as from other local sources. It should be stressed however that Finnish national statistics on regional economic growth and development are limited in that they do not as yet go back beyond 1998 at the time of writing. The OBR database, therefore, can be regarded as the main quantitative source of information for Northern Ostrobothnia in high technology industries and can be considered reliable.

While nationally published data permits an analysis of what is happening in the national macro economy, the OBR database enables us to follow the micro economy of Northern Ostrobothnia. Specific firms or sectors and their pace of evolution or development as well as changes of ownership can be identified and this permits an analysis of the structural changes taking place specifically in the region.

In this research Chapter 6 strongly relies on the data from the OBR database.

In- depth interviewing

Being an observer has enabled the author to create a personal network with the people working in the focal points of this phenomenon. Some of those links have been of use for carrying out in-depth interviews in order to create a deeper understanding of the phenomenon. The interviews are presented in Table 3.6. All the selected people have long experience in their fields at senior managerial levels. All of these interviews have been tape recorded, transcribed and archived by the author. The interviews were semi-structured and the aims and questions were different for each interviewee. The selection of interviewees represents different areas of the phenomenon, and all were available for intensive discussion and to contribute additional material, which is not the case with public sources. All the interviews proceeded chronologically with questions such as *what, how* and *why*. Three of the interviewees were from the public sector, each of them, aside from being actively involved in the events, also represented important institutions in the process; the five other

interviewees were from industry, and represented key industrial areas since the mid 1980s. These interviews had the purpose of supplementing other sources of information particularly about Nokia, because while the OBR provides a good understanding of other firms and technological fields, Nokia is not so well documented from "*the inside*". For the author particularly, these interviews were a learning process about the real events in Nokia. In the interviews there were no difficulties in openly discussing and recording more detailed information. There was, however, a problem about the availability of relevant information, e.g. a fire in Nokia's Haukipudas plant in the late 1990s destroyed much of the early stages' documentation and due to organisational restructuring, it has been difficult to find the people who have this kind of knowledge. Most of the interviewees have left Nokia since the interview, and it is impossible to repeat these again. In this sense, the documentation in this research is valuable.

After the interviews, the written documents were analysed by the author, the important elements were taken out, compared with other sources, and then transferred to the empirical parts of this study. The three public sector interviews are mainly in Chapter 4, and the others are in Chapter 5 and in the latter part of Chapter 6.

Table 3.7 The interviews conducted in this study

When	Who	Focus of interview
18.3.2002 9.00 – 12.00	Tauno Jokinen, Nokia Mobile Phones	Nokia Mobile Phones in Oulu
9.0 2002 13.00 – 15.30	Juhani Oksman Professor of Telecommunications and former Rector of Oulu University One of the early visionaries	The Oulu Phenomenon from the Oulu University's point of view.
6.6. 2002 13.00 – 17.30	Martti Hannula Director of Regional Development in the Northern Ostrobothnia Council Early adopter of the phenomenon	The changing role of regional development policy
7.6. 2002 9.00 – 12.30	Paavo Similä Director of Business Affairs (former) in the city of Oulu Early adopter of the technology based strategy	The evolution of the Phenomenon in 1980s and 1990s

24.6. 2002 9.00 – 12.00	Seppo Veikanmaa Managing Director of Outel Oy, pioneer firm in telecommunications	The Phenomenon from the "pioneers'" point of view
15.11. 2002 9.00 – 12.30	Toivo Vilmi Nokia Networks Kimmo Väänänen, Nokia Networks	Nokia in Oulu
4.11. 2003 12.00 – 14.00	Markku Kuivalainen Head of Global Partners Management Nokia Networks	Networking, partnering in Nokia Networks

It was intended to interview Professor Matti Otala, but because of his failing health, this was not possible.

Document analysis

The role of document analysis in this study has been firstly to provide a wider understanding of the important issues such as the situation in Northern Finland in the 1950s and 1960s, the establishment of the university and its basic mission, industrial development before the high technology development in traditional industries (e.g. the History of the University of Oulu, the History of Kajaani Oy and the History of Nokia). A second role has been to complete the information obtained from other sources such as interviews (e.g. the interviews with public sector people could corroborate the planning documents, the interviews particularly with Nokia people were able to corroborate the research carried out on Nokia). Thirdly, the written documents helped to demonstrate different cases such as Polar Electro, Nethawk, Elektrobit and Scanfil, and the role of Medipolis in Chapter 6, and finally the annual reports were relevant in reviewing Nokia's concentration in electronics and the fast growth of Technopolis.

Statistics

Statistics were used in this study to demonstrate the paradigm shift (such as the share of R&D funding, the changes in industrial structures), the population growth of the Oulu Region and the development of unemployment. The following statistics were used:

- R&D Input in some OECD countries from 1985 – 2001. Published by Tekes 2002; (based on the Statistics Finland, 2002)
- The distribution of research and development by sectors in Finland. Published by Tekes 2002 (based on Statistics Finland, 2002)

- The population of Northern Finland, of Northern Ostrobothnia, and the city of Oulu between 1950 – 2000. Statistics Finland, 2002, Population Statistics
- The number of jobs in the main industries in the Oulu Region 1950 –2001, Statistics Finland, Labour market Statistics, 2000 and 2001; Kerkelä and Kurkinen 2000 (based on Statistics Finland, Labour Market Statistics)
- Research and development expenditure in Finland 1989 – 2002. Published by Statistics Finland, Science and Technology Statistics, 2003
- The share of R&D expenditure in four counties in Finland 1998 – 2001. Published by Statistics Finland, Science and Technology Statistics, 2003
- The share of R&D expenditures in the years 2000 and 2001 in five regions. Published by Statistics Finland, Science and Technology statistics, 2003
- The proportion of unemployed in Finnish labour 1975 – 2002. Published by Ministry of Labour, 2003
- The proportion of unemployment in Finnish labour from 1971 – 2002. Published by Statistics Finland, 2003, Labour Market Statistics
- The development of jobs and number of business units 1983 – 2001. Statistics Finland, 2002; OBR 2002
- Statistics Finland, Business Register, 1990, 1995 and 2001

Articles in newspapers and www documents

These sources were used to demonstrate the importance of the topic, and most of them were used in Chapter 1 and Chapter 6 to explain the roles of important people (such as Kuokkanen) and firms from which information cannot be obtained in other ways (e.g. Microcell). The internet sources were used mainly to provide more background information (such as Finnfacts and Nokia History). The list of articles used in this study is presented in Table 3.8

Table 3.8 The list of articles

Article	Topic
Kaleva 18.3.1982	Interview of P Malinen, Ministry of Trade and Industry
Business Week 25.9. 1995	*Article*: "In the Cold and the Dark, High-Tech Heat"
Suomen Kuvalehti 44/1996	Article: *"Oulupolis, Rössypottukaupungin kosto"*
Kaleva 6.3.1999	Interview of K Wikstedt, former Director General of Nokia

Tekniikka & Talous, 30.11.2000	Interview of L Kuokkanen, Managing Director in several telecommunication firms
Kaleva 3.5.2002	Article about Scanfil Oy and Wecan Eletronics Oyj
Talouselämä 24.5.2002	Interview with J Takanen, Managing Director of Scanfil Oy
Talouselämä, 11.4.2003	Interview with A Torstensson, Managing Director of Microcell Oy
Kaleva 26.4.2003	Article about Microcell Oy
Kaleva 4.5.2003	Article about the biotechnology industry in Oulu
Kaleva 5.6.2003	Interview with I Oppermann, Director of the Center for Wireless Communication
Kaleva 14.8. 2003	Article about Filtronic LK

Specific material

During the interviews new material was obtained particularly about the role of the City of Oulu and the Spatial Planning Office of Northern Ostrobothnia. After the interviews more detailed material was obtained both from Professor Oksman and Nokia. These new materials greatly contributed to the writing of the latter part of Chapter 5, and parts of Chapter 6 (topics like Consortia Cooperation and Industry and University Cooperation).

Triangulation

Altogether the information gleaned from the above documents can be used for triangulation and validation purposes when pursuing specific issues. The triangulation in this study means the triangulation of data (see Yin, 1994) or evidence (see Morris, 1997) from multiple sources. Multiple sources are used in the empirical parts (Chapters 4-6) and this triangulation is demonstrated in these chapters. In writing the empirical Chapters 4 and 5, the interviews played an important role, providing qualitative material to the questions *what*, *how* and *why*. This kind of material was essential when answering the research question at Level 1 (see Table). Also it was essential to link these qualitative data with other types of data, such as other published documents and statistics, when it was possible. Some examples of these are e.g.

- the early investments in electronics both in Nokia Oy and Kajaani Oy, which were presented in interviews but also could be found in company histories and earlier reports;
- the increase in local responsibilities in the regional development in 1970s presented in an interview, and was also familiar to the author from his own experience, and could also be

found in the Official Planning Documents in the 1970s (The Spatial Planning Office of Northern Ostrobothnia 1976-)

- the emergence of technology intensive regional development strategy in the early 1990s in the Oulu Region, with a strong influence on the local co-operation culture and reflecting the national development policy (the Center of Expertise Programme). This was presented in an interview, but could also be found in the official strategic documents and the evaluation reports by the Center of Expertise Programme; the co-operation between the University of Oulu and Nokia (and some others) was presented both in the interview with Oksman and the interview with people in Nokia. The specific material obtained after the interviews facilitated the analysis of Oulu´s position in the telecommunication industry (more in Chapter 6)

Participant observation, opportunities and problems

The evidence-collection strategy, participant observation, provides both opportunities and problems. The main opportunities are as follows:

- extensive observation enables an understanding of both the context, process and behaviour (Remeney et al, 1998)
- access to the events or groups can be obtained, which otherwise are not accessible (Yin 1994)
- it enables the observer feel and experience the reality from the viewpoint of someone "inside" the case study and use all the five senses (Gummesson, 1993; Yin, 1994)
- it enables the manipulation of minor events (such as meetings) in the case study (Yin, 1994).

The involvement can also cause problems such as:

- the roles may be mixed, due to bias and friendship, the researcher may become an advocacy and supporter of a group or organisation instead of being a neutral observer (Yin, 1994; Remeney et al, 1998)
- the observer's attitudes and beliefs can dominate the observation process and block events or fail to see all (*"what's in here"* and *"what's out there"*, as Morris claims (Morris, 1997))
- participant observation is time-consuming

In this research the abovementioned opportunities and problems are present and the use of multiple sources and triangulation, are the methods used to eliminate the problems of close participation.

3.3 Conclusions

This chapter discusses the research strategy and the methods of research to be followed. The study is an analytical and explanatory case study, of the Oulu Phenomenon from 1970 – 2002. The research is conducted on three levels; at macro level in describing and explaining the Oulu Phenomenon in its context, part of the changing Northern Finland and Finland; at regional level in describing and explaining the content of the Oulu Phenomenon in a more detailed way and finally at a concluding level in collecting together the pieces of information produced at macro and regional levels. The outcome of all this is an explanation of the Oulu Phenomenon as a whole, the changing role of its different actors in this phenomenon, and the changing regional and national aspects of this kind of development with future benefits for the national Finnish economy.

4 The Oulu Phenomenon

INTRODUCTION

This chapter reviews the Oulu Phenomenon, its origins, early stages, and emergence. The first part of this chapter describes the early formation processes of the phenomenon; the latter part analyses its initial consolidation processes in the setting up of the Technology Park and how it developed subsequently. A critical element in this development path was the establishment of the University of Oulu in 1959. However, besides the university, other factors were essential. To start this new kind of development, there was a need for people who had initiative, had the necessary vision and were capable of implementing those new initiatives. In addition, resources to start highly risky experimental ventures were also required. This whole development process in the early stages has to be viewed against the situation in the region, i.e. what was really happening in Northern Finland at the time, and why. The author of this research is not a specialist in sociological issues, which are very relevant, when trying to understand the circumstances of the time and this aspect has not been discussed in the literature review. Some of the changes are examined to demonstrate the environment for facilitating economic and social developments which can assist in understanding what can be termed as the driving forces, leading to the "*phenomenon*". However, the situation of Northern Finland in the 1950s and 1960s needs to be discussed to put the circumstances into context.

This chapter discusses the topics represented mainly at level 1 in Table 3.2, but some topics from level 3 are also included. The focal points are the university and its department of electrical engineering, the changing regional development policy which raised local responsibility, the early pioneers using the new development options in traditional industry and in regions like Kajaani, the emerging activities in the Oulu Region and its evolving industrial policy, and finally the growth and strengthening role of the Technology Park of Oulu.

4.1 The preliminary stages of the Oulu Phenomenon

Although the aim of this research is to analyse the Oulu Phenomenon as a case study covering the years 1970 – 2002, it is important to discuss some critical events occurring in the 1950s and 1960s in Northern Finland and the Oulu Region. These events formed the basis for the phenomenon. In the

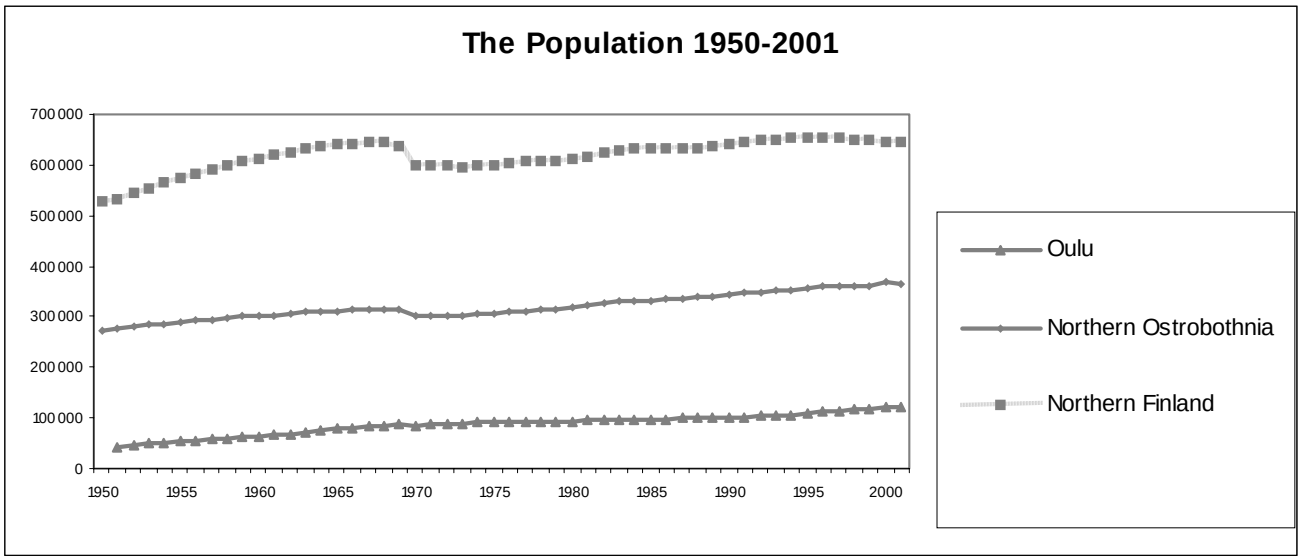
1950s, the dominant livelihoods in Northern Finland were in agriculture and forestry. After World War II, the paper and pulp industries and the mechanical wood industry gained the upper-hand due to the availability of raw materials. The exploitation of mineral reserves started in the 1950s and several iron ore mines were opened. In the 1960s the steel industry started to develop and steel factories were established in Raahe (Rautaruukki Oy) and in Tornio (Outokumpu Oy) (Lackman, 1998).

The notion of "Northern Finland" in this context means the provinces of Lapland and Oulu. They cover about 50 % of the area of the whole country and they are both areas with a very low density of population. In 1960 the province of Oulu had 7.2 and the province of Lapland 2.2 inhabitants per km². The average population in Finland was 14.6 inhabitants per km².

Figure 4.1 shows the development of the population size in Northern Finland, in Northern Ostrobothnia, and in the city of Oulu. In the 1950s Northern Finland's population grew very fast but, at the end of 1960s through to the early 1970s, the population decreased from 644,000 to 598,000 in just two years. The main reason for this was the emigration of the post-war generation (i.e. born after World War II) to Sweden and to Southern Finland (Hannula, 2002; Pulliainen and Siuruainen, 2000) in search of work or higher education.

However, the population of the city of Oulu and the region of Oulu grew steadily due to the university and other institutes of education, and to other growth industries and services. The Oulu Region was a unique place in the overall trend which attracted in-migration and to some extent stemmed the north to south national migration.

Figure 4.1 The population of Northern Finland, of Northern Ostrobothnia, and the city of Oulu between 1950 – 2000.



Source: Statistics Finland, 2002

Table 4.1 demonstrates the development of jobs in the main industries in the Oulu Region from 1950 to the year 2001.

Table 4.1 The number of jobs in the main industries in the Oulu Region 1950 –2001

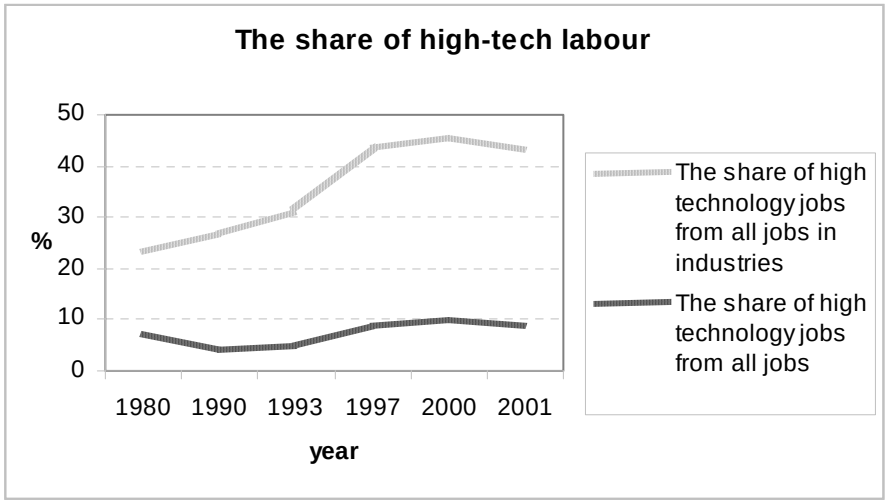
The year	1950	1960	1970	1980	1990	1993	1997	2000	2001
All jobs				42115	75352	61427	73213	83131	84446
All industrial jobs	8571	9597	10751	13034	12523	10232	15002	18139	17131
Mechanical wood processing	1974	1490	1427	1363	733	416	341		
Pulp and paper	1452	1690	1652	1613	479	726	1023		
Food industry	897	1165	1393	1620	1544	1120	905		
Electronics and electrotechnical				3051	3351	3217	6547	8281	7448
Chemical engineering		210	829	1145	1460	1296	1020	838	

Sources: Statistics Finland; Kerkelä and Kurkinen 2000

In the 1950s, mechanical wood processing was the most important industrial job provider; by 1960 the pulp industry had become number one. Comparable figures in electrotechnical industries are not available before 1980. When observing the development figures from a longer perspective, these are both cyclical and structural in terms of the number of jobs. In 1980 the electro-technical and

electronics industries had taken the leading role, dominated in the early 1970s and 1980s by cable manufacturing and later by telecommunications. The total number of industrial jobs generally increased into the late 1980s, when a dramatic slump began due to the financial recession in Finland. However, the unique growth in the electronics industry in the late 1990s, more than doubled the number of industrial jobs and countered this downward national trend.

Figure 4.2 The share of high technology jobs of all industrial jobs and from all jobs in the Oulu Region



Sources: Statistics Finland; Kerkelä and Kurkinen 2000

Figure 4.2 demonstrates the percentage of high technology jobs in the Oulu Region. In the 1990s, this percentage rose to almost half of all the industrial jobs, and to roughly 10 % of all jobs in the region.

4.1.1 The University of Oulu: the second state university in Finland

When trying to understand the importance of the University of Oulu in creating the environment for new industries in Northern Finland, this research here indicates that the establishment of the University of Oulu in 1959 was perhaps the most significant decision in the regional development policy of Finland (Jakkula et al, 1983; Lajunen 1998; Hannula, 2002; Oksman, 2002). When the University of Oulu started in 1959, there were 10 higher education institutes in Finland catering for 21 000 students. The economic and social developments in Northern Finland deviated from the national developmental trends, after World War II the density of the population and the standards in

education were below the national average. In the 1940s, initiatives were taken in order to set up a new university in Oulu which would focus especially on the problems of Northern Finland. These early initiatives did not produce any significant results early on. In the 1950s, there were vigorous general discussions about decentralising university higher education away from Helsinki and spreading it among the central and northern regions of Finland. These discussions and the earlier initiatives ended in the appointment of a higher education committee in December 1952 to prepare an extensive master plan to harmonize the policy in higher education (Lackman, 1998).

The committee, called the Myrberg Committee after its chairman, considered the decentralization of the universities, and its aim was to extend the research and teaching activities outside Helsinki. After four years of deliberation the committee in 1956 suggested the following:

- resources should continue to focus on the existing universities;
- Turku should be developed as an intellectual centre to counterbalance Helsinki (there were two private universities in Turku, at the time);
- Oulu should have a higher educational institute for Northern Finland, for research in forest resources and to provide instruction in technical and social sciences.

Additionally in Oulu a teacher education institute was set up, and this became legally established in 1956 to alleviate shortages in the supply of teachers and so help improve the educational standards generally in the North, which was part of central government educational policy. This was a preliminary step towards the establishment of a new university.

The drive to establish a university in the north continued, and in 1956, the Kaitera Committee, which had been set up by the Council of State, recommended eventually that a university be established in Oulu as a counterbalance to Helsinki (Lackman, 1998). It must be stressed that the decentralisation of universities away from the south of the country should be seen as only one part of a wider national government regional policy attempting to develop the northern economy.

The mission of the University of Oulu

The mission of the University of Oulu was defined by law as follows: *'The mission of the University of Oulu is to contribute to free research and scientific education, provide the highest*

level of technical teaching and carry out research in the fields considered particularly important to the economy of Northern Finland" (Lackman, 1998) .

This mission from 1958 imposed a new regional responsibility for the area. The main idea of that time was to take care of the resources in Northern Finland but also to improve further both the profile and educational standards of the region, where the percentage of people able to start education at university level was generally well behind other parts of the country (Lackman,1998). In fact, the foundation of the university had wider implications. Not only did it attract students, it also generated employment and brought visitors to the area to the benefit of the service industries and generated wealth in the area. Therefore although setting up the university was a financial cost to the Finnish Treasury in the short term, it should perhaps be viewed more as a long-term investment rather than an immediate drain on resources. Indeed, at the time of writing the university has a student population of 16,000 jobs and provides direct employment for approximately 3,000 people (University of Oulu, 2004). Basically the university has expanded in line with the rest of Finnish Higher Education and should be viewed as a nurturer of academic talent in Northern Finland (see Florida, 1999).

At the time the University of Oulu was founded, the immediate perceived industrial need was the generation of electrical power to supply the pulp, paper mining and metallurgical industries, but once the river system had been harnessed to this end, the priorities changed to examining how modern electricity-related industries could meet the wider needs of the region and bring about industrial and structural diversification. This in itself called for new industrial skills of a higher order, at degree level, that could best be provided in a university setting (Oksman, 2002).

The Faculty of Technology was started as one of the initial three faculties in 1959. There were three departments in that faculty, the department of architecture, the department of construction and the department of industrial and process engineering. In 1965, the departments of mechanical and electrical engineering were established as separate entities (Salo, 1998; Oksman, 2002). Fundamental to long term development was the Department of Electrical Engineering which became a critical element in the chain of events contributing to the Oulu Phenomenon via the subsequent growth of the early electronics industry, as understood in this study. The first professor appointed in the fledgling Department of Electrical Engineering in 1966 was Juhani Oksman (later rector of the university; interviewed in this study), who had a Ph.D. in technology. Oksman began

immediately to shift the research and education priorities increasingly towards electronics, and very soon the department was an active promoter of electronic based industries in Northern Finland.

When analysing the early stages of the department and the importance of the university and the Department of Electrical Engineering for the Oulu Phenomenon, Oksman (2002) said *"The foundation of the university and the Department of Electrical Engineering were necessary but not enough. It became evident that there was no need to increase the electrical power supply to the region except in a marginal sense. In any case, a vacancy arose in the Department to create a professorship in electronics. I tried to find a capable person for that vacancy and I found Matti Otala. He soon proved me right in that he was a very dynamic person. He started very soon to speak about the electronics industry as a new, promising industry in Northern Finland, and supported his arguments with the low cost of workplace creation. Then the question was, who was willing to pay for these low-priced workplaces. They were not to be found easily. However he persevered by writing articles and giving lectures which ultimately led to the emergence of a popular movement to get the new industry to the area. This then came of age in the birth of the new electronics industry in the province of Lapland"* (Oksman, 2002).

Otala, stressed the importance of the electrical and electronics industry in his inaugural professorial lecture in February 1971 entitled *"The Development Potential of the Electronics Industry in Northern Finland"*. He summarised the development potential under five headings: inclusive and effective education, an increase in the amount and quality of higher education and research, the founding of a research centre in electronics, the creation of a regional development policy to support labour-intensive industry, and the implementation of an active regional industrialising policy. His opinion at that time was, in 1980, that one third of the whole electronics industry in Finland could be located in Northern Finland, creating approximately 12,000 jobs (Jakkula et al, 1983).

4.1.2 Local Activity Increases, Local Responsibility Recognised

In the 1970s the regional development and industry policies were highly centralised in Finland. Industrial policy at a local level consisted mainly of industrialisation committees who worked with the provincial authorities. Their main task was to prepare statements and comments for the central administration in Helsinki. The central administration had regional offices in the provinces under

the auspices of the Ministries of Trade and Industry and of Labour[2]. The role of these offices was to provide services locally through the allocation of funds for regional development activities both for public and private organisations as well for industrial training. By the 1970s a high degree of autonomy had been delegated to the local planning offices under the control of the relevant municipalities and cities which also provided funding for their operation activities (Hannula, 2002).

Alongside the Spatial Planning Offices were a series of industrial planning committees whose role was to take initiatives on behalf of the central Government (through the Provinces) and later to produce plans for industrial development. The membership of those committees was drawn from the main industries and local authorities. Indeed, it was from the deliberations of the Lapland Committee that the first initiative to bring industrial renewal crystallized.

This committee recommended to the Ministry of Trade and Industry in September 1971 that a subcommittee concentrating on the electronics industry should be set up. The task of this group was to examine the potential development of the electronics industry and the viability of educational facilities to effect this in the province of Lapland. The Ministry of Trade and Industry approved this subcommittee, but suggested that the subcommittee should be a joint committee for both provinces, Oulu and Lapland (Jakkula et al, 1983; Oksman, 2002; Hannula, 2002).

The new subcommittee started its activity and focused on educational issues and how to encourage the expanding electronics industry in Finland to invest in Northern Finland. The subcommittee was a forum for discussion; it could order enquiries and increase awareness about the development potential of the new industry, but little more than that. Perhaps the most important outcome of the work of this subcommittee was its organization of three high level seminars on the electronics industry. These seminars were held in the years 1973, 1974 and 1975, the seminar in 1973 was in Oulu, in 1974 in Rovaniemi and in 1975 in Kajaani. These seminars provided fora for sharing opinions on the electronics industry, its future prospects, its demands on education and research and also any local factors relevant for this kind of industry. In organizing these seminars the role of the University of Oulu and its Department of Electrical Engineering were fundamental. At the time of writing this research, some 30 years after those seminars, they are still referred to as ‘golden moments’ (Jakkula et al, 1983; Oksman, 2002; Hannula, 2002).

[2] At this time the author was working in the Ministry of Trade and Industry in Oulu

The main idea was to encourage the electronics industry, to locate to the north and so create jobs especially for women, mainly lower wage jobs in assembling; this was because males still tended to find employment in agriculture, forestry and to a growing extent in the region`s metallurgical industries. There does not seem to have been, according to the information available, any clear research into the need for future professionals. The first ideas for realising the visions of the time were based on the perception that, as a place of manufacturing in the emerging electronics industry, Northern Finland could reach a strong position. The setting up of the new manufacturing plants was cheaper than in the old heavy industries and also the workforce would be more stable than in Southern Finland due to local working ethics and less competition for jobs. These early perceptions became partly true in the 1970s in the case of Nokia (see Chapter 5), but not in the following decades.

Oksman described the results of that era as follows (2002): *"Nothing significant happened until a mining counsellor[3] Mr. Tähtinen, was in touch with Otala. This led to the founding of Jänkä Electronics (later Kajaani Electronics) which employed university trained engineers in research and development. But, as we know now, this project struggled and the product range was very haphazard. They lost about 100 million marks and failed to generate any income despite investing a similar sum in development. Similarly, Nokia at this time had its own department of electronics but it was limping along and, despite all attempts to entice it, it proved impossible to persuade it come to Oulu. Likewise, Otala tried to get Philips of Eindhoven to set up a plant to manufacture televisions, but they, too, were unwilling. Then we faced a long incubating period, when nothing significant occurred. We had here in Oulu an electro-technical industry, manufacturing cables, and when the jobs in electronics begun slowly to increase, Professor Otala had the idea to combine them both and launched the term: electro-technical and electronics industry. So we still had the belief, that the electronics industry would fulfil its promises, although to some extent we used this conjuring trick to combine these two different industries, the cables had already been invented, and there was no need for engineers but for manufacturing employees"* (Oksman, 2002).

When observing these events longitudinally, Kajaani Oy was the first firm to try to change tack and diversify into electronics and this experience is described below.

[3] The Mining Counsellor is a Finnish job title indicating a high position in industry, in this context the CEO of Kajaani Oy

4.1.3 Kajaani Electronics, the First Electronics venture in Northern Finland

The CEO of Kajaani Oy was the first to share the vision of Oksman and Otala. Kajaani Oy was a pulp and paper mill, established in 1907 and located in Kajaani, a city 200 kilometres southeast of Oulu. The reasons for setting up Kajaani Oy were the availability of raw material for mechanical wood and pulp and paper processing, the proximity of rail transport and the hydropower available from the rivers. The firm started with the name, Kajaanin Puutavara Osakeyhtiö (meaning Kajaani Mechanical Wood Company), and was strongly linked to the region due to the competitive advantages of that time. In the 1950s, Kajaani Oy provided more than 6,000 jobs, mostly in the purchasing of raw materials. By the 1980s, the total number of jobs had dwindled to roughly 2,900, of which 600 were in purchasing. In a region of 100,000 people, the local importance of Kajaani Oy was high (Virtanen, 1982).

In the latter part of the 1960s, Kajaani Oy was worried about the limited raw materials necessary for the growth of the company. There were two options open. The first option was to increase the added value of the processes. The alternative option was to build a multi-branch company, which could also be less dependent on the cyclical nature of the economics of the pulp and paper industry (Virtanen, 1985).

At the end of 1969, the board of Kajaani Oy held a discussion about entering the electronics industry. Arguments in favour of this were as follows: the research support available from the University of Oulu, its low risk compared to the paper industry, it was seen as a labour intensive industry which would answer the need for employment for the female population. Moreover, in relation to total costs the share of transportation costs were minimal. It was also hoped that by being a pioneer firm in the electronics the area, it would benefit from the locally available highly skilled resources – although limited in quantity - for which there was so little competition at the time. In February 1970, the board of Kajaani Oy took the decision to start up in the electronics industry (Virtanen, 1985).

Kajaani Electronics started in 1970 as an instrument department of Kajaani Oy. The first product was a measurement instrument, called CORAM developed in the University of Oulu for quality control in the bleaching process in pulp production. The process control systems and devices for the pulp and paper industry developed since then, now form a main product group for the Kajaani electronics industry. The second product group was in audio electronics for Suomen Yleisradio

(Finnish National Radio Broadcasting Company). Until 1975, the electronics division operated as part of the paper mill complex before moving to its own premises in the Kajaani Industrial Park.

During those first years the research and development department was located in Oulu, but in 1977 this department moved to Kajaani at the same time as the firm bought the products of a bankrupt firm in the Oulu Region, Eurodata Oy, and moved that to Kajaani, too. This formed the third product group for Kajaani Electronics: taximeters, and fare collection systems for public transport. In 1977, the number of employees employed in Kajaani Electronics as a whole totalled more than 200, and in 1981 this number had risen to 252 employees. which was just less than 10 % of the total number of employees in the whole organisation (Virtanen, 1985; Oksman, 2002).

Table 4.2 shows the turnover figures for Kajaani Electronics between 1970 – 1982.

Table 4.2 The turnover figures for Kajaani Electronics between 1970–1982. The figures are in millions of Finnish Marks

Year	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Turnover			0.9	1.3	4.4	7.8	12	17.8	30.8	31.3	38.9	22.9

Source: Virtanen, 1985

As the table above demonstrates, the electronics industry in Kajaani Oy grew very slowly and was not particularly profitable with no visible increase in growth until the end of the decade. This was a cause of concern within the company and there was frequent discussion about the viability of the venture.

One starting point for analysing the Kajaani experience could be the company growth model. The first stages of growth are existence and survival (Churchill and Lewis, 1983), or growth through creativity and direction (Greiner, 1973), or conception and development (and later commercialisation – Kazanjian and Drazin, 1990).

When setting up a new industry in an older firm, the situation is not the same as starting up a totally new firm in an open field. When looking at the Kajaani Oy's specific company related factors - namely its financial resources, personal resources and system resources - there appears to

have been little or no serious limitations on the resources available. In this example, the creation stage seemed to last for one decade. Despite losing 100 million FIM in the process (Oksman, 2002), Kajaani Oy created much needed new businesses in the 1980s. One fundamental factor, when trying to understand the subsequent development path of Kajaani Electronics lies perhaps in the history of Kajaani Oy (Virtanen, 1985) and its company culture. Kajaani Oy had a long history in a very traditional type of business, whereas its new emerging electronics was based on young, enthusiastic engineers, investing in R&D (on a smaller scale than in the original industry), the commercialisation of R&D, and intensive co-operation with the University of Oulu. Adaptation to this may well have proved difficult and it is perhaps safe to speculate that the firm's traditional culture might well have been an inhibiting factor in managing this type of change.

During its first decade, the nature of Kajaani Electronics was like a new venture but with one difference: the financial resources were not the limiting factor. In this way, Kajaani Oy acted more like an incubating organisation for a new technology based industry (see the Figure 2.3). The aim of Kajaani Oy in the late 1960s was to diversify into new industries, but in the early 1980s after only ten years the strategy changed and the company started to refocus again and return to its core business, i.e. pulp and paper.

This was due primarily to shifts in the owner's goals (see Churchill and Lewis, 1983) because of problems in the firm's core industry, which led to a restructuring of processes (closing down an older pulp mill and investing in the paper mill). As a result, the electronics industry became less important and eventually it was decided to restructure the electronics arm in 1983. In that year Kajaani Electronics (until then a small unit of the company) was split into two separate firms, Kajaani Electronics Oy and Edacom Oy. The former firm continued the process control business with the second firm responsible for audio electronics, cashier systems, taximeters and fare collection systems. Kajaani Oy stayed on as a shareholder of those firms and then sold them both in 1984 (Virtanen, 1985; Oksman, 2002).

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Kajaani Electronics was, in fact, sold to Valmet Automation Oy and the activities stayed in the Kajaani area (employing about 150 people in 2004). Later Oy Edacom Ab was split into three separate firms, Edacom Oy concentrated on cashier systems, Jutel Oy concentrated on audio electronics and Buscom Oy concentrated on fare collection systems. Jutel Oy and Buscom Oy moved eventually to Oulu and continued business there (Virtanen, 1985; Marttila, 2000). Kajaani

Oy, at the time of writing this thesis, is no longer an independent company; it is now a production unit of UPM-Kymmene.

Although the Technology Park of Oulu has been cited in many articles as the first park in Finland and the Nordic countries, the importance of the Kajaani experiment should not be underestimated. Kajaani Oy was the first firm in Northern Finland to invest in research and development in the electronics industry thus laying the foundation stones of a new industry in both Kajaani and in Oulu. The Industrial Park in Kajaani was where the electronics industry first emerged (and still exists) but it was not a Technology, nor a Science, Park as it had no links with higher research and educational institutes.

The early steps of Kajaani Oy have been reviewed by Oksman as follows: "*Nokia started to work in electronics in the 1960s, and Kajaani Oy wanted to follow this model, it wanted to repeat what Nokia did, without making the same mistakes. Kajaani created its mass of employees in research and development, and later split into four different firms, some of which came to Oulu. In the end, the investment in research and development was not wasted, it generated new firms and businesses and all of these found customers. This was the most notable investment of that time, partly done with the wrong premises and wrongly, but what we learn here is that it is always worth taking chances; being passive takes us nowhere"* (Oksman, 2002).

4.1.4 Nokia enters electronics in Oulu in the early 1970s

Nokia Electronics, which was later to change the industrial structures dramatically in the Oulu Region as elsewhere in Finland, started its activities in the Oulu Region in 1972 when it started the production of U.S. military radio equipment by license for the Finnish military forces. Nokia was partly following the idea presented by Professor Otala, i.e. that Northern Finland could be a suitable place for the manufacture of electronics. However, it should be noted that the University of Oulu was not a reason for Nokia's presence in Oulu in the early stages, as it had been for Kajaani Electronics.

Professor Oksman further explains the reasons for this: "*During the years 1972 –1985 there was no need for engineers in Nokia, all the people were in production. Nokia came here, because in the Helsinki region there was a high turnover of employees, the competition for a workforce was strong and the employees were not very mobile. In Oulu there was no such competition; Nokia was the*

biggest and most attractive employer, the workers had stability and the salaries were reasonable. These were the reasons for Nokia first coming to Oulu. Research and development activities started later in Oulu. Until that time, the engineers specialized in telecommunications and were educated in our Department mainly for employment in the radio industry and as tele-operators. The telecommunications industry came later."

Nokia in Oulu in the 1970s was, as Oksman says, mainly a manufacturing unit and in 1983 it employed about 500 people in the Oulu Region. Nokia and its role in the context of Oulu are treated separately and discussed more in depth in Chapter 5.

4.1.5 VTT (The Technical Research Centre of Finland) starts in Oulu

The Technical Research Centre of Finland (known in Finland as VTT) is a contract research organisation involved in many international assignments. VTT is a state owned research organisation with about 3000 employees (in 2002), 10 % of whom are in Oulu. VTT provides a wide range of technology and applied research services for its clients, private companies, institutions and the public sector. Until 1974, the VTT activities were concentrated in the Helsinki region, close to the Helsinki University of Technology. When the University of Oulu was established in 1959, there was a discussion about the importance of research for Northern Finland and suggestions were made to address this issue. Indeed, at its foundation the University of Oulu was given the responsibility of carrying out research on the economy of Northern Finland. This idea did not progress much in the 1960s, and one reason for that was the then somewhat negative political attitudes towards university-industry co-operation in the dominant student body (Mannerkoski[4] , 1998).

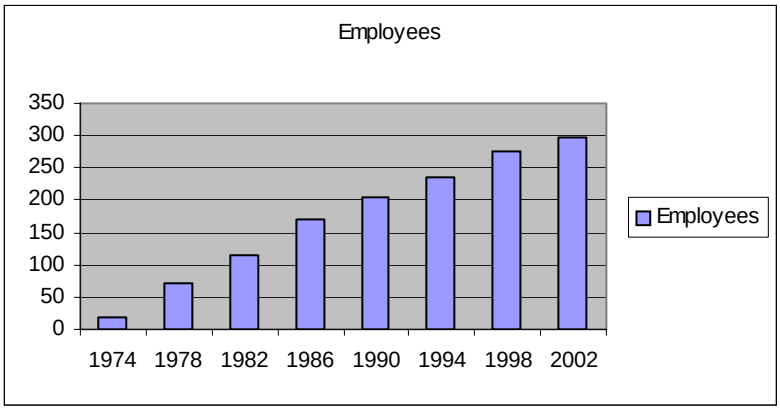
In the1970s, the situation improved to enable the setting up of a new research laboratory of VTT in Oulu. Otala argued strongly for the setting up of a research centre in electronics in Oulu. His vision became reality. In order to start the operations of VTT in Oulu, the Rector of the University of Oulu, Professor Mannerkoski, the Director General of VTT, Dr. Jauho (secretary in the abovementioned Kaitera committee) and others had a meeting in Oulu in February 1972, and the result was a recommendation to establish a regional branch of VTT in Oulu. The new laboratories - a laboratory of electronics and laboratory of construction technology - commenced in 1974. After

[4] Markku Mannerkoski was the rector of the University of Oulu 1968 – 1987 and Director General of VTT 1987 – 1999.

this, a Computer Technology Laboratory was set up in Oulu in 1982 which later integrated into the electronics laboratory. Finally and most importantly, this must be viewed in the overall context of national government policy in its attempts to foster growth in less-developed areas.

Figure 4.3 demonstrates the increase in staff of VTT in Oulu. In the beginning, there were two laboratories and the number of employees was about 20 people. During the next three decades, the number of people increased to 300, of which over 80 % worked in research in electronics. The percentage of researchers in construction technology in contrast was less than 10 % (Annual Reports of VTT; Lammasniemi,1998).

Figure 4.3 The number of employees in VTT Oulu



Sources: VTT Annual Reports; Lammasniemi, 1998

At that time, the Oulu Region was like a desert in the electronics industry and most of the customers for the new laboratory had to be found elsewhere. One task for the VTT laboratory of electronics was to activate industrial change and a renewal process. Furthermore, the new laboratories had a national responsibility although they were located in Oulu.

Prior to the growth of the electronics and communications industries in Oulu and its environs, the main customers of VTT Electronics were mainly located in the south of Finland. The percentage of local firms as customers only started to grow at the end of the 1990s, but soon represented more than 50% of the customer base (Lammasniemi, 1998). In the 1980s, the electronics industry was assumed to become a modern tool in creating more added value in industrial processes. As the

fields of research in electronics have progressed down through the years, so has the degree of co-operation between firms, VTT and the university which in 2003 now operate in areas such as: advanced interactive systems, embedded software, optoeletronics and numerous telecommunications systems. An overview of the financial base of VTT electronics in 2002 is shown in Table 4.3 below. The basic funding comes from the Government (37%), from the private sector (35%), and 15% from TEKES. However, it must be stressed that while TEKES provides funding, it is VTT's primary role to advise on and to conduct research in collaboration with educational establishments and public or private concerns.

Table 4.3 An example of the funding of VTT Electronics in 2001 (Turnover stood at 175 MFIM /29.4 M€)

The Share (%)	Source
35	domestic private sector
37	government budget
15	Tekes funding
5	other funding from the domestic public sector
5	funding from the foreign public sector
3	other income

Source: VTT Annual Report, 2001

No studies have been done on the catalysing effect of VTT laboratories in Oulu in the creation process of firms. But there is close cooperation between the laboratories and local firms. One example of this can be seen in the "*second start*" of the mobile phone industry by Nokia in Oulu in 1985. A small research group, originating from VTT, started to develop embedded software for mobile phones and this new start grew remarkably in size later (see Chapter 5). A typical example of the role of VTT in research lies in its collaboration with the Universities of Oulu and Lapland in Virtual Prototyping Services which is financed by Tekes (Infotech Report, 2002).

4.1.6 Regional Development Policy and Local Responses

Out-migration in rural Finland continued throughout the 1960s and 1970s. This time it was not simply to Helsinki and the south, but also to Sweden and Oulu itself (See Figure 4.1). At the end of the 1960s, although the birth rate was higher than the mortality rate, the population in Northern Ostrobothnia had decreased from 310,000 in 1965 to 300,000 in 1970. Such a fall prompted the Spatial Planning Office to embark on a more interventionist policy. Beginning with higher

education, and despite the university's important role in deflecting a student drain to Helsinki, it still did not entirely stem the overall rural drift of young educated people and so new initiatives had to be adopted to persuade students to stay in the area (Jakkula et al, 1983). Among the new initiatives was the provision of degree courses in technological subjects and computing in localities outside Oulu in places such as Raahe and Kajaani in 1972 and 1974 respectively.

The main duty of the Northern Spatial Planning Office was to tackle the population and employment problems by improving the area's infrastructure. As part of the recovery policy to stimulate the economy following the 37 per cent devaluation of the Finnish Mark in 1967, a programme of public investment was implemented in the early 1970s. This entailed infrastuctural improvements particularly in the north (i.e. roads, telecommunications, hospitals, schools and new universities). Similarly, new ways of encouraging the establishment and growth of firms were found; these included subsidies for investments and the establishment of the new Regional Policy Fund (Hannula, 2002). The 1970s can then be regarded as a turning point in regional development. In Northern Ostrobothnia, the direction of migration was gradually reversed, the population started to grow and in the 1970s, jobs in industries grew from 20,000 to 30,000. In the Oulu Region the growth in jobs jumped from 10,700 in 1970 to 13,000 in 1980 (see Table 4.1). Perhaps the most important trend at this stage was the decision making was becoming increasingly more decentralised and devolved in the hands of the local authorities (Hannula, 2002).

As discussed earlier, Northern Ostrobothnia`s economy remained under the dominance of its traditional industries such as the wood based, pulp, paper industries and the food industries. At the beginning of the 1970s, the new electronics industry was recognised mainly as a promising provider of jobs for women. Moreover, at the same time the Regional and City Authorities began to develop their own business policies. This decade became known as the period of planning. The Spatial Offices were financed by the Regional and City Authorities, and these offices produced comprehensive regional plans, which included development prospects for individual industries (Regional Plans for Northern Ostrobothnia for the years 1972-2000, 1976-1985, 1981–1990 and 1985-1995) These planning documents were the first of their kind at regional level and to some extent guided regional development strategies. One result of this kind of activity was the forcing of the Municipalities and Cities to become more professional in their approaches to economic and business development. Business policies at local level emerged and new consultants were hired with the help of part-funding from the Ministry of Trade and Industry. Thus, industrial spatial

planning took on a new form; the first versions of local industrial parks began to take shape, and their focus lay largely on the less developed regions (Hannula, 2002).

A prophetic vision can be found in Otala´s[5] comments, when in 1971 he was asked what the electronics industry could really achieve (Hannula, 2002): "*If somebody can determine a need, for example a Finn wants to be in contact with a Chinese person, that contact can be made independently of the location, and if money is not a limiting factor, this contact will be realized with a device no bigger than a watch."* This prediction came true after 30 years.

As mentioned earlier, the 1970s was a time when a a series of regional economics seminars were held, and towards the end of the decade the thoughts about the electronics industry being a low wage, manufacturing intensive industry, began to change. The most important step in this direction occurred at the seminar in Oulu in October 1978 when it was declared that:

"*Electronics is not a low-wage industry but an industry based on highly skilled employees in competition in a demanding business environment different to the environment of the traditional industries in terms of knowledge, physical infrastructure and logistics. In Northern Finland, only Oulu and the Oulu Region are able to create that kind of environment* " (Hannula, 2002).

This new concept was first captured in January 1981 in the planning document, *The Spatial Plan for Northern Ostrobothnia 1981 –2000*. In this plan, the electronics and data processing industries were identified as potential and suitable industries for the Oulu Region and for Northern Finland as a whole. The Spatial Planning Office recommended reserving an industrial suburb or area for the new proposed industrial concentration. It was stipulated that the designated area should be located close to the university campus, where VTT`s laboratory of electronics was also planning to locate. The new businesses were assumed to be spin offs from the activities of the university and VTT`s electronics laboratory. This is the first document where a specific suggestion for a park was made.

4.1.7 The Electro Technical and and Electronics Industries in Northern Finland in the 1970s

The numbers presented below in Table 4.4 show the development in the electro technical and electronic industries in the whole of Northern Finland. This development, however, took place

[5] In the late 1980s, as the then Director of Technology in Nokia, Otala predicted that compared to the television business, the mobile phone business will be like "nappikauppaa" (= a button trade). During the following decade, this was not realised as Otala expected (Häikiö 2001).

mainly in Oulu. A more comprehensive view of the situation is possible from 1983, by which time the electronics sector had acquired an increasing percentage of the jobs.

Table 4.4 The development of the electro technical and electronic industries in Northern Finland from 1960 –1983

Year	Total Number of jobs (approx.)	Electro technical (approx.)	Electronics (approx.)
1960	20	20	-
1964	80	80	-
1970	350	330	20
1974	1480	1120	360
1978	2600	1600	1000
1980	2800	1650	1150
1983	3452	1785	1667

Sources: Jakkula et al, 1983; Oksman 2002

Table 4.5 shows more clearly Oulu's position in the emerging electro technical and electronics industries in Northern Finland. As pointed out, the more significant concentrations of the electronics industry emerged in the Oulu Region, where two cable factories were the visible symbols of this new kind of business. Similarly, in the southern part of the province of Oulu, the electro mechanical industry started to appear, in the already discussed Kajaani region - with Kajaani Electronics - and then in the area of Kemijärvi, which started manufacturing electro mechanical components.

Table 4.5 The segmentation of the electro technical and electrical industries in Northern Finland in 1983

	Total		In electro technical		In electronics	
	Jobs	Firms	Jobs	Firms	Jobs	Firms
The Oulu Region	2620	32	1692	14	928	18
The rest of the province of Oulu	962	24	83	6	609	18
The province of Lapland	140	6	10	2	130	4
Total	3452	62	1785	22	1667	40

Source: Jakkula et al, 1983

In the Oulu Region there were three early birds in electronics in the 1970s, and those firms later grew significantly; Aspo Elektroniikka was set up in 1973 to produce components for the electronics industry; Polar Electro, established in 1977, started to develop heart-rate monitoring systems; and Lauri Kuokkanen Oy in 1976 began to develop duplex filters for the telecommunications industry. In the southern part of the province, two other significant firms were formed: Pohjanmaan Tele in 1970, focusing on telecommunication technology, and Scanfil Oy in 1976, concentrating on the electromechanical industry (Jakkula et al. 1983, Veikanmaa 2002).

4.1.8 The Founding of the Technology Park in 1982

At the beginning of the 1970s, the new technology based industries had started to sprout up in Oulu and Kajaani, and the University of Oulu had assumed its role as a new job creator in the electronics industry in Northern Finland. For the city authorities of Oulu, it took a decade to enthuse about this issue.

Under the guidance of Oksman and Otala, the idea of a new kind of technology village was suggested for the first time in a plan of the Spatial Planning Office in 1978. This idea became more widespread at the beginning of the 1980s judging from the public lectures, the newspaper articles and local discussions. These initiatives led to the appointment of a working group for the city of Oulu in order to prepare the foundation of the technology park. The basic plan was drawn up in 1981, and the Technology Park was established on March 31, 1982. The shareholders in the beginning were 19 companies, the University of Oulu and the City of Oulu, which initially held a 50% shareholding. The 19 share-holding private companies at the beginning can be divided into the following main groups:

- Construction firms (Insinöörityö Oy, OMP- Yhtymä Oy, Oulun Rakennus Oy)
- Energy producing firms (Turveruukki Oy, Pohjolan Voima Oy, Oulujoki Osakeyhtiö)
- Local tele-operators and the local newspaper (Oulun Puhelin Osakeyhtiö, Kaleva Kirjapaino Osakeyhtiö)
- Basic industries (Kajaani Oy, Rautaruukki Oy, Kaapeliteollisuus Oy)

Additionally, smaller shareholders included individual companies such as Automaatiotekniikka Oy, Temelex Oy, Tornion Elpolar Oy, KOPO- Konepohja Oy, Farmos Yhtymä Oy, Regional Development Fund and MKT- Tehtaat (Annual Report of the Technology Park, 1982). Most of the shareowners were local or had their origins in Northern Finland. This structure of the ownership

meant that the financing of the Park was shared equally between the City and the other shareholders including the university. Indeed, the implementation of this policy in many ways represents a solid example of the Triple Helix Theory at work

The Technology Park started its operations in 1982 in rented premises, and in 1985 it started to build its own premises in the Linnamaa area, close to the university campus. The rented premises were used until the 1990s. The objectives for the Technology Park were (according to its Annual Report of 1983): firstly to enable the setting up of new firms and secondly to enable existing new technology firms to locate or even relocate to Oulu. Although Oulu city was the prime location for this type of industrial expansion, the smaller municipalities and townships tried to follow its example and locations were set aside for creating small industrial parks in townships and even nearby villages or towns such as Haukipudas, Ii, Tornio, Kemi, Oulunsalo and Pudasjärvi, all of which are within easy reach of support services from either the Oulu and Lapland Universities or neighbouring polytechnics. Gradually, therefore, small new high-tech industrial developments spread across the Oulu Region and Northern Ostrobothnia, bringing an overall change in the industrial landscape.

In parallel with the foundation of the Technology Park, new activities were started in the city to promote further activities in regional business development. A driving force behind this was the visible structural change in local industry. Fundamental to this was the first plan for regional development drawn up by consultants. The main idea in this plan for the city authorities was to declare the city of Oulu a “City of Technology” in 1983 (Similä, 2002).

In terms of regional business policy, the 1980s was the period of technology image building. On the one hand, the Technology Park was growing and attracting new firms there and, on the other hand, the city of Oulu was investing in the creation and building of its technology image. The City of Technology project was aimed primarily at the prime objective of attracting firms to move to Oulu. Promotional exhibitions were held to encourage new firms to move into the park. One of these was run in conjunction with the university. As part of this exercise a research officer was hired to build and increase the research relationships between the SMEs and the university laboratories and was funded by the city of Oulu. This project was not very successful because the university was more concentrated on the needs of the larger firms and industries and focused more on basic rather than commercially viable research. The project was scaled down at the beginning of the 1990s and the research officer acquired a new role of promoting research and subsequent innovations inside the

university. This later developed into the Innovations and Research Service Unit within the university.

In the 1980s, 45 new technology based firms were set up in the Oulu Region, which employed in 1991 five or more employees (Paloniemi 1991). When analysing the reasons for the establishment of those firms, the dominating factor was the promising market based on the use of new technology but, on the other hand, the main challenge to tackle were the problems in marketing their products from what was considered a somewhat isolated and remote geographical position.

From the city's point of view, the 1980s was quite a stable period, the number of jobs increased, particularly in the public sector and there was little pressure to create a new policy. When the technology city campaign generated more publicity, there was more and more discussion and doubts rose about whether this kind of development was fruitful for the city´s long term development (Similä, 2002). There were alternative choices surrounding the growing role of public services and possible role of increasing employment in the area´s traditional industries. Matters, however, came to a head in the late 1980s when plant closures in the pulp and food industries increased the goodwill towards the new growth industries. The focus in regional development policy then shifted decisviely to the promotion of new technology intensive firms (see Table 4.1). The really important lesson to be taken from this experience was the increasing benefit of the city authorities, business interests and the university acting in concert as a public-private partnership in public decision-making on regional policy.

4.2 The 1990s, A Cluster-Based Development Policy and strong growth emerge

Of fundamental importance to the growth of the new industrial sector were the attempts to create a forum in which experiences and best practices could be shared. Key to this was the setting up in the late 1980s of a new association, Revontuliryhmä ry (The Northern Lights Association) whose aim was to create new initiatives to develop the regional business environment and to help new firms in solving any managerial problems that might arise. One of the first initiatives of that association was the development of a new, high-level management training programme. This initiative led to further cooperation with the university which in turn led to the establishment of an Executive MBA. Most of the new entrepreneurs were from technology background and had little or no knowledge of the intricacies of business and so this programme was organised to help them overcome this handicap.

The first programme was organised in 1989 –1990 and has run on a two year basis ever since. To date approximately 150 students have completed the programme successfully (Similä, 2002).

The second eMBA programme started in spring 1991 and one of the participants in that was the Director of Business Affairs in the city of Oulu, Paavo Similä. This programme offered him a new forum to look at the next development stages in regional business strategy. Influenced by several discussions with other participants in the programme, he started a new type of development process for regional business strategy. Compared to the earlier process in the 1980s, which was done by consultants (resulting in the establishment of the Technology Park and the city of technology image), the subsequent process deviated substantially. The second strategy process lasted from autumn 1991 to the end of 1992. This was a joint process with different partners, almost 40 managers and opinion leaders in local firms and other organisations were involved in this process. The result of this was "*The Business Development Strategy of the Oulu Region*" and Oulu City Council accepted it in June 1993 (Similä, 2002).

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The growth of the role of a shared strategy process

The introduction to this strategy read as follows: "*In the beginning of the 1990s Finland, (like many other European countries), headed for a difficult, financial recession and partly new circumstances without clear visions. Despite the centralised government and power structure, the development activities of the regions and strengthening of urban districts have increased. The responsibility for the future development of the regions is shifting towards the public and private sectors in those regions and urban districts."* (City of Oulu, 1993)

Together with the content of the strategy, the value of the process was emphasized in the plan as follows: *"All the participants in this strategy process have realised the importance of this kind of shared process and have invested their time without any compensation to create a shared vision to implement the needed change. It is also emphasized that this process shall not be one single event, but strategic planning for an ongoing process."* (City of Oulu , 1993)

The strategy stated that although most of the jobs in the Oulu Region remained in the more traditional industries, in commerce and the service sectors, potential growth in these areas was too weak to create a significant number of new jobs, especially when unemployment was running at around 20% during the recession of the early 1990s. The action in the development strategy had

little option but to focus instead on the areas where the growth potential was assumed to be. Several targets were then set for the year 2000 which were: firstly to create 9,000 new jobs, of which 4,000 were to be in new technology-based firms, secondly, to reduce the unemployment rate to 10% and, thirdly, to make use of the new risk capital 200m FIM allocated by Teknoventure (a local Venture Capital Firm), and finally in the year 2000, Oulu would aim to have 10 foreign owned manufacturing firms in the area (City of Oulu, 1993)

In the strategy document, the key technologies were defined as focal areas in the development. These technologies were telecommunications, optoelectronics, biotechnology and medical technology. The strategic goals stayed on a general level and did not specify much beyond the core technologies. The creation process of the strategy was influenced by Porter's cluster theories, published in 1990. In this process this was viewed as a good tool for understanding the situation in local business when the financial environment was unstable and in a recessionary period (Similä, 2002). In each of these clusters, broad strategic development projects were defined. Although the analysis process followed Porter's model and factors, the definitions emphasized the role of cooperative research in both the firms and in the university.

At that time the telecommunications industry was considered a promising industry with particular growth potential, and one strategic project for this cluster was the provision of resources for research and development activities. The strategy included a proposal for the Ministry of the Interior to launch a pilot version for the Centre of Expertise programme in order to develop the implementation of a regional business strategy. Partly on the basis of this, the Ministry of the Interior prepared a new development programme at national level, which was launched in 1994.

4.2.1 Responsibility in business policy development and management in the areas of new technology is given for the Technology Park

In 1994, the Finnish Ministry of the Interior opened the Centre of Expertise programme. This decision had been influenced by the progress made in Oulu's attempts to transform its economy (Ahola, Kortelainen, 1997). The new programme was based on open competition in which the various regions had to make an application in order to obtain the Centre of Expertise status. In the first round, 18 applications were made and the Finnish Council of State nominated 11 Centres of Expertise, of which 3 were network based Centres and 8 were regional Centres. In the evaluation of the applications, the proposal from Oulu was evaluated as the best (Similä, 2002). One reason for

this was the strategy work done in the previous year, which gave Oulu a flying start, leaving the others a long way behind.

In the wake of the acquisition of Centre of Expertise status came the responsibility of creating and managing business policy, which followed upon the decision taken by the City Council to delegate the development of new technologies to the Technology Park Company. Regional development policy was then split into the technology intensive Technology Park, while the City Council retained responsibility for the more traditional sectors. In this delegation process there was more push from the city side than pull from the Technology Park side, but the new concept was adopted quickly. Most of the regional development activities linked to new technology development were conducted inside the Centre of Expertise Programme, and became an “umbrella” for development (Similä, 2002).

The Executive Team for the the management of the Centre of Expertise Programme, funded by both the national government and participating firms, included members of the board of directors of the Technology Park, the Rector of the University of Oulu and the Director of the Regional Council. Table 4.6 demonstrates the level of funding of the Centre of Expertise Programme in the Oulu Region between 1994 and 2000.

Table 4.6 Annual Financing of the Centre of Expertise Programmes in the Oulu Region 1994 - 2000

Year	MFIM
1994	4.9
1995	5.8
1996	8.6
1997	9.0
1998	10.9
1999	12.5
2000	12.5

Source: Annual Reports of the Technology Park.

Until 1994, the regional development was based on work on a general level with the focus on industrial activities and the encouragement of new technology initiatives. The Technology Park provided premises and a new kind of environment with a full range of administrative support

services, including staff training, seminars and specialist lectures for new, small firms as well as for larger newcomers. The overall development strategy still remained the prerogative of the City Council´s Office of Industrial Affairs.

In the second concept, resulting from the Centre of Expertise Programme, the actors and their roles were restructured. The Technology Park took up the central role in the development of technology-based industries and the subsequent development which took place later in technology-based forums. The first projects started under this new concept were Pro Eletronica, which concentrated on manufacturing technology in electronics. Another was the Centre for Wireless Communication (CWC) which focussed exclusively on telecommunications technology and, finally, the Centre for Wellness Technology which involved bio and medical technologies. These projects, it must be remembered, were based on the earlier foundation stones laid by the Office of Industrial Affairs in 1992- 1993.

The first entirely new forum was the Mobile Forum[6], starting in 1996, which took charge of the development of communications technology. At the same time this sector faced enormous growth, and the main concern of firms in the telecommunications industry was to manage this (see Figure 6.1). Of all the various projects, the Pro Electronica and CWC projects progressed quickly. The other forums (the wellness, software and biotechnology forums) started more slowly and only gained higher levels of visibility in the early 2000s. An example of the widespread commitment to this kind of work can be demonstrated by the development process of the Center of Expertise Program for the years 2003 – 2006, in which more than 250 people were involved. In the next section, one of the other large development projects of the 1990s - Pro Electronica - is discussed below as an example.

Pro Electronica

The Pro Electronica project was led by the Centre of Expertise Programme between 1995–2001. Inside the main project, there were several subprojects not all of which were managed by the Centre of Expertice Programme (CEP) organisation, but were in close co-operation with the programme. VTT also presented its own forecasts for the development of the electrical and electronics industries. According to these, the telecommunications industry generally was facing a fast growth

[6] Mobile Forum is a research, development, and business program aimed at facilitating the creation of future mobile applications and services in order to create new business in the field. (The definition of Mobile Forum's Aim in 2003)

situation, doubling its volume in the next five years. The challenge for the Pro Electronica project, therefore, was to enable it to happen in the Oulu Region. The region was recognised as strong in research and development, which provided most of the turnover in the electronics industry, but the level of skills in subsequent product manufacturing was lagging behind (Kess et al, 2003).

The region was assumed to be a suitable place due to the presence of education institutes at various levels, (mainly the university and the newlydesignated polytechnic) and their close links with the firms in electronics. The Pro Electronica project operated on three levels: firstly by training production specialists (in firms and in educational institutes), secondly by developing an operating environment by setting up a new training factory in nearby Pohto, obtaining training technology transfer programmes from Scotland from the Scottish Electronic Manufacturing Center and, finally, by introducing elements of flexible manufacturing to development and production processes (Kess et al, 2003).

The special value of the Pro Electronica project was (see Kess et al, 2003) the provision of training in electronic manufacturing skills in an era of fast growth. The estimated reduction in time compression was 2-3 years. While the project linked the firms closer to the research institutes, what was lacking was a continuity of process. The length of the project was too short in order to create a new and lasting infrastructure and network culture. The structural changes in manufacturing (see Chapter 6) changed the situation in the Oulu Region. and affected the roles of the key actors. Oulu began to find itself facing competition not only from other parts of Finland but globally, particularly in manufacturing. In the year 2002, however, the project was revived under the next concept, NCEM (Northern Centre of Electronics Manufacturing), within the Mobile Forum of Oulu. As this programme is still in its infancy, it is too soon to discuss it meaningfully here.

Infotech grows up in the Oulu University.

When regional strategies developed in 1995 under the “umbrella” of the CEP for each of the main sectors, the University of Oulu proposed setting up a high-level research centre concentrating on information technology. The aim of the centre was to operate in the area of basic and applied research and to become in the future one of the national Centres of Excellence[7] in this field. The

[7] The Centre of Excellence programme is one of the Academy of Finland's most important forms of research funding for promoting the development of creative research environments. All centres of excellence in research represent the cutting edge in their respective fields. The national strategy for centres of excellence in research has been jointly developed with the National Technology Agency (Tekes), which also contributes to the funding fot those programmes.

idea for the centre was to create an environment for the development of world-class research units by advancing long-term research, research training, cooperation with the university on a cross faculty basis and increase international contacts with overseas universities. After this initiative Infotech Oulu started its activities on 1997. This was not a new organisation in the university, but rather a new way to activate the research, increase the status and level of research and adopt initiatives coming from industry and CEP. Experts outside the University of Oulu selected the research groups for Infotech to ensure the high quality of research personnel. For the first three year period (1997 –1999) electronic and measurement technology, information processing engineering, software engineering and wireless communicationa were selected as the main areas of research conducted by Infotech. There were ten research groups from the faculties of technology and science at the University of Oulu and the Technical Research Centre of Finland (VTT) participating in those activities.

The following is an overview of the projects during the first three years:

- Advanced Control Methods
-Advanced Wireless Communication Systems and Signal Processing
- Electronic Materials, Packaging and Reliability Techniques
-High Speed Electronics
-Intelligent Systems and Hypermedia
- Machine Vision and Media Processing
- Mathematical Models and Algorithms for Wireless Telecommunications
- Optoelectronic Measurements
- Software Process Improvement Research Action Laboratory – SPIRAL
- Virtual Reality Technology in Future Telecommunication Products and Services- VIRGIN

As a result of this new organisation, there was an increase in the volume and quality of research output which was greatly helped partly by the setting up of a new inter-disciplinary graduate school that concentrated on research in the relevant areas, and partly due to success in obtaining funding from the Finnish Ministry of Education. A further result of this exercise was to increase interaction between industry and the research institutes, such as VTT. Indeed, it was very much the latter that helped to attract external funding for the research as shown in Table 4.7. By 2000 the share of external funding from TEKES had risen to 39% of the total, and from private enterprise to 23.9%.

Table 4.7 Financial figures of Infotech Oulu 1997 – 2000. (MFIM)

Person years	1997	1998	1999	2000
By external funding	133	198	227	324
By internal funding	42	54	66	84
Total /person years	175	252	293	324
External Funding (MFIM)	34.6	68.8	72.5	96.1
From which private (MFIM)	7.5	16.1	16.7	23.9

Source: Annual Reports of Infotech

The research capacity of Infotech has grown to more than 300 person years. Almost half of these are doctoral candidates with about 50 per cent of these doing research on a part-times basis while working in their respective companies. The membership of Infotech´s Advisory Board is drawn both from industry and other research institutes and they are subject to external evaluators who assess Infotech's work on a regular basis. Though considerable progress has been made, Infotech has yet to obtain Centre of Excellence status as laid down by the Finnish Academy, but is considered to be on course for receiving this accolade (Academy of Finland 2003).

4.2.2 How Oulu Region Succeeded in R&D funding

Much has been made so far of the growth of research in the Oulu Region. However, the vitality of this needs to be placed within the wider Finnish context. Figure 1.1 demonstrated the development of R&D expenditure in Finland and some OECD countries between 1982 – 2001. More precise figures of the R&D expenditure in Finland between 1989 – 2002 are given in Table 4.8. R&D expenditure in Finland has grown from 1.8 % of GDP in 1989, to 3.5 % of GDP in 2002. The share of business enterprises in that whole development has grown from 61.6 % (in 1989) to 70.7 % (in 2002).

Table 4.8 Research and development expenditure in Finland 1989 – 2002.

	1989	1991	1993	1995	1997	1998	1999	2000	2001	1) 2002
	€ million									
Business enterprises	924,8	975,1	1 048,5	1 373,4	1 916,7	2 252,8	2 643,9	3 135,9	3 284,0	3 446,7
Public sector 2)	286,1	357,5	379,7	374,4	408,6	443,9	470,1	497,4	500,9	520,8
University sector 3)	290,2	378,0	367,5	424,6	579,5	657,8	764,8	789,3	834,1	905,2
Total	1 501,2	1 710,6	1 795,8	2 172,4	2 904,9	3 354,5	3 878,8	4 422,6	4 619,0	4 872,7
as % of GDP	1,8	2,0	2,2	2,3	2,7	2,9	3,2	*3,4	*3,4	*3,5
	%									
Business enterprises	61,6	57,0	58,4	63,2	66,0	67,2	68,2	70,9	71,1	70,7
Public sector 2)	19,1	20,9	21,1	17,2	14,1	13,2	12,1	11,2	10,8	10,7
University sector 3)	19,3	22,1	20,5	19,6	20,0	19,6	19,7	17,8	18,1	18,6
Total	100	100	100	100	100	100	100	100	100	100

1) Estimate on the basis of inquiry responses and other calculations.
2) Incl. private non-profit sector.
3) Incl. central university hospitals since 1997 and polytechnics since 1999.
* preliminary data

Source: Statistics Finland, Science and Technology Statistics, 2003

Unfortunately, these figures cannot be disaggregated on a regional basis prior to 1998. Nevertheless, Table 4.9 illustrates the percentage of R&D in four counties, Uusimaa (Southern Finland, includes Helsinki), Varsinais- Suomi (Southwest Finland, includes Turku and Salo), Pirkanmaa Southwest-centre, includes Tampere) and Pohjois- Pohjanmaa (Northern Ostrobothnia, includes Oulu). Of the 20 counties in Finland, these four represent more than 80 % of the expenditure and in all of them Nokia has a large operation. The dominant area is clearly Uusimaa which includes Helsinki. The other two main areas, Varsinais-Suomi and Pirkanmaa, too, are situated in the more heavily populated south., whereas Ostrobothnia is the northernmost of the four mentioned, but still rates higher than the remaining 16 counties in terms of R&D expenditure.

Table 4.9 The share of R&D expenditure in four counties in Finland 1998 – 2001.

County	R&D Expend. 1998		R&D Expend. 1999		R&D Expend. 2000		R&D Expend. 2001	
	milj. €	%	milj. €	%	milj. €	%	milj. €	%
Uusimaa	1 513,2	45,1	1 749,6	45,1	1 990,1	45	2 057,7	44,5
Varsinais-Suomi	343,5	10,2	375,3	9,7	466,1	10,5	466,6	10,1
Pirkanmaa	439,4	13,1	547,5	14,1	633,9	14,3	694,1	15
Northern Ostrobothnia	378,1	11,3	437,1	11,3	511	11,6	527,3	11,4

Source: Statistics Finland, Science and Technology Statistics, 2003

Table 4.10 gives more detailed information of the regions of Helsinki, Tampere, Oulu, Turku and Salo. When comparing this table with the previous table, it is obvious that the percentages of those sub-regions almost match the percentages of the counties to which they belong. In Northern Ostrobothnia, the percentage of expenditure on R&D per capita in 2000 was second highest after Salo. These figures then give further strength to the important role played by R&D in bringing about growth and development in Ostrobothnia´s high tech industries as a whole. However, the caveat is that high levels of R&D expenditure in itself does not necessarily guarantee success or profitability in any industry, sector or individual firm (Tidd et al, 2001).

Table 4.10 The share of R&D expenditures in the years 2000 and 2001 in five regions.

Sub region	R&D expenditure 2000			R&D expenditure 2001			Real change 2000-2001	R&D / Citizen 2001
	Whole	Share of All R&D Expenditure	Share of Enterprises	Whole	Share of All R&D Expenditure	Share of Enterprises		
	milj. €	%	%	milj. €	%	%	%	€/citizen
Helsinki	1 964.5	44,4	67	2 033,8	44,0	67	0,5	1 707,2
Tampere	606.3	13.7	77	669.2	14.5	78	7.2	2 231.6
Oulu	491.8	11.1	79	510.9	11.1	78	0.9	2 675.3
Turku	267.6	6.1	58	269.4	5.8	57	-2.2	947.3
Salo	178.0	4.0	100	181.2	3.9	100	-1.1	2 900.6

Source: Statistics Finland, Science and Technology Statistics, 2003

4.2.3 The Technology Park changes to Technopolis

The role of Technopolis in the developement of Oulu`s high tech development has been referred to previously. However, its role was not merely passive; it contributed directly not only to growth in

its immediate region but became a dynamic factor in other parts of Finland as the following discussion shows.

As considered previously, the first business task of the Technology Park was to organise premises for new firms. During the first year or so the Technology Park operated in rented premises in the city centre. In 1986 the building of its own premises started in the Linnanmaa area, close to the university campus. In the late 1990s, development was swift. The number of firms in the Park rose from 90 in 1990, to 200 in 2000, with the workforce expanding from 800 to over 2,000 in the same period. Furthermore, although the Park started out as a regionally based entity in 1982, subsequent growth and development allowed it to grow in its own right and it expanded its activites to other parts of Finland. For instance, a similar operation was opened at Vantaa near Helsinki airport and in 1993 was listed on the Helsinki Stock Exchange[8] (Virtanen, 2001; Annual Report of Technopolis, 2003) Similarly, a year earlier it became the majority shareholder in the Innopolis Oy Science Park at Espoo in the Uusimaa county in Southern Finland.(Annual Report Technopolis, 2003). In other words, Technopolis has become a successful company in its own right.

Indeed, the progress of Technopolis as a company parallels that of the growth of the high technology industry as a whole in Finland. This can be demonstrated by looking at its development in the 5 stages listed below. The company began with a regional mission in 1982 but by the turn of the century had achieved national status:

1. 1982 – 1987, slow growth /concept development (Kazanjian and Drazin, 1990), regional mission;
2. 1987 – 1989, fastened growth/survival (Churchill and Lewis), regional mission;
3. 1989 –1994, slow growth in the number of jobs, fast growth in the number of firms, survival, and regional mission;
4. 1994 – 2000, fast growth, success and stability (Churchill and Lewis), focal organisation in charge of the development of regional, technology intensive industries, involved in global competition, of national importance, in the year 1999 listed in Helsinki Stock Exchange;
5. 2000 – 2002, growth by building new premises in Vantaa (in the greater Helsinki region) and by acquisition (in the year 2002 it held the majority of the shares of Innopolis Oy, the Science

[8] On 30th June in 2003 the major shareowners of Technopolis Plc were; Erkki Etola and Etra Invest Oy Ab 22.8 %, the city of Oulu 18.3 %, Juha Hulkko 4.0 %(establisher of Elektobit) and Finvera Oyj (earlier Regional Development Fund) 3.8%, Yleisradion eläkesäätiö 2.6% and the city of Vantaa 2.3%.

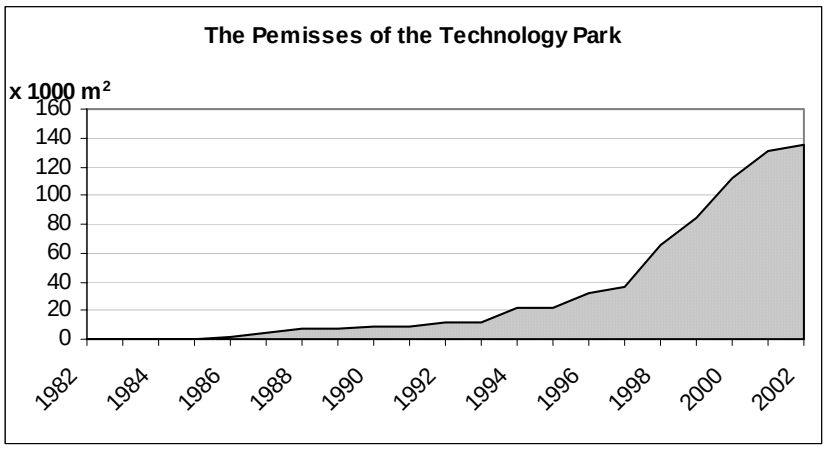
Park in Espoo), in the year 2002 it became Finland's largest company specializing in the provision of operating environments for high tech companies.

In other words, in recent years much of the responsibility for regional development in technology intensive areas in Finland has fallen in the hands of Technopolis Plc. Its main role lies in the provision of services to create a competitive environment in which the firms on its premise thrive.The services available consist of the following elements:

- premises for technology-based firms, effectively customised to the client;
- networks emphasising the possibilities of a technology centre to promote interactive cooperation between firms (the Centre of Expertise Programme is one key element for this);
- tailored services for firms;
- being part of a successful image (the strong image of Technopolis Plc spreads to its tenant firms).

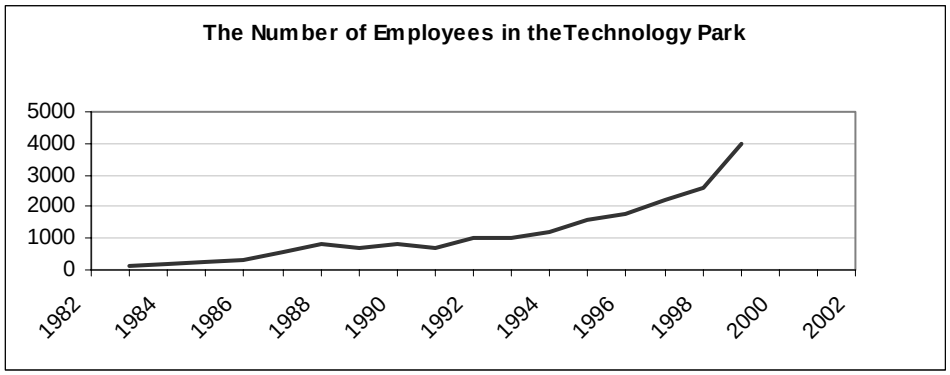
Returning specifically to the Oulu situation, the next Figures (4.4-4.6) demonstrate more obviously the development of the Technology Park in terms of premises, number of employees and number of firms, between 1982 – 2000.

Figure 4.4 The Premises of the Technology Park in 1982 – 2000



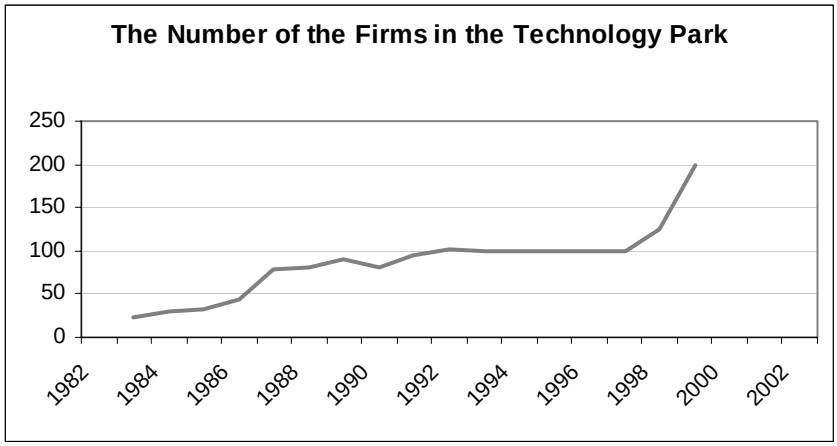
Source: Annual Reports of the Technology Park 1982 – 2002

Figure 4.5 The Number of Employees in the Technology Park 1982 – 2000



Source: Annual Reports of the Technology Park 1982 – 2000

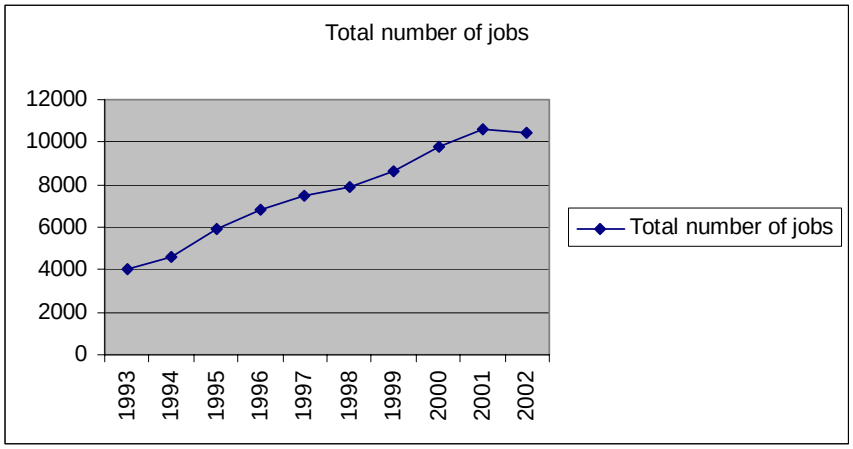
Figure 4.6 The Number of Firms in the Technology Park in 1982 – 2000



Source: Annual Reports of the Technology Park 1982 – 2000

Collectively these Figures demonstrate the overall pattern of growth in firms and employment on Oulu´s Technology Park. Growth in the 1980s was steady, and picked up towards the end of the decade then stablised before embarking on a high upwards trend during the decade`s last quinquennium. As Figure 4.7 shows, only 25 per cent of high tech jobs were located in Technopolis in 1993, but by 2000 it accounted for 40 per cent of the total (including those in its annex premises at Kempele which were opened in 2000). Much of the increase in employment, however, was due to Nokia`s local and global expansion in the late 1990s as discussed in the following chapter.

Figure 4.7 The development of high technology jobs in the Oulu Region 1993 – 2002



Source: Oulu Business Review - database 1993 – 2001

A great deal has been made of job creation in Northern Ostrobothnia through the development of new industries and sectors, but as shown below these proved no panacea for all of the regions ills as unemployment remained a persistent and stubborn factor in the region.

The main goals set for the year 2000 from the strategy of 1993 were: 9,000 new jobs, of which 4,000 were in new technology-based firms, an unemployment rate of 10% and by the year 2000 to attract10 foreign owned manufacturing firms to Oulu.The first goal was reached, more than 6,000 new jobs were created in new technology based industries (Figure 4.7) and 3,000 in other industries (Table 4.1).

4.2.4 The Development of Unemployment

Although the new technology based industries grew and also other industries increased their number of employees, the unemployment rate stayed at a high level. Figure 4.8 shows the unemployment rates since 1975 nationwide, in Northern Ostrobothnia and in the city of Oulu. In the 1990s, the unemployment rate in Oulu was higher than both the national average and the average in Northern Ostrobothnia. This issue has been analysed (see Kerkelä and Kurkinen, 2000), but no clear explanation has been found. The nature of unemployment has changed, in the earlier decades the problem was in rural areas, in the 1990s the unemployment came to cities and towns like Oulu partly due to the national recession. The strong development in the new technology based industries

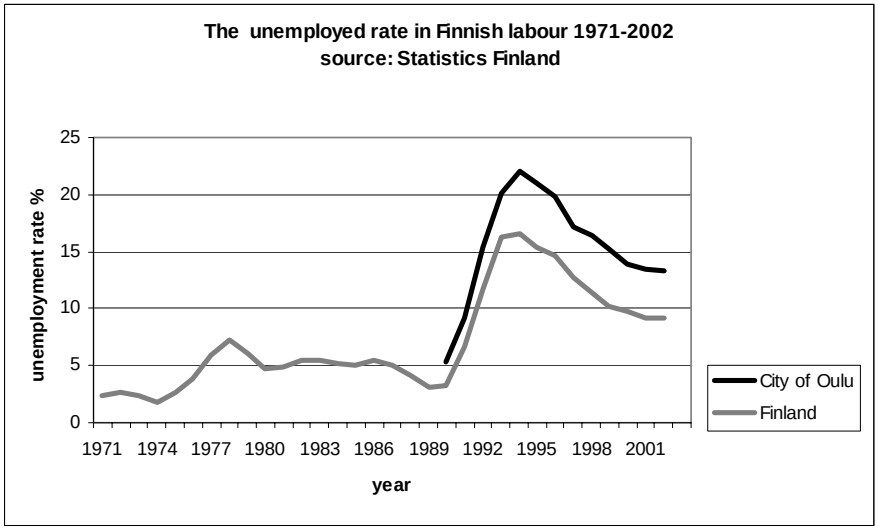
has not been able to defeat this problem, but in time could help reduce it. All that can be gainfully said at this stage is that unemployment is concentrated in two groups. The first comprises older workers who have been by-passed by the technology revolution, and when offered retraining refused to accept it. The second group consists of school leavers with few academic qualifications who are, therefore, unable to find employment in the high tech firms which demand primarily graduate entry. Indeed, one can speculate that the situation in Oulu would be much worse without the Oulu Phenomenon.

Figure 4.8 The proportion of unemployed in Finnish labour 1975 – 2002. (Oulu since 1991-2002)

Source: Ministry of Labour

Figure 4.9 demonstrates the unemployment rate in Finland from 1975 – 2002 based on Statistics Finland. In this figure the unemployment rate is systemically lower than in the figures from the Ministry of Labour, based on the number of job applicants.

Figure 4.9 The proportion of unemployment in Finnish labour from 1971 – 2002.



Source: Statistics Finland, 2003

4.3 Conclusions

It is clear from what has been said in this chapter that the Oulu Phenomenon was not a simple affair. It involved a great deal of cooperation between the central government, the local authorities, private enterprises and public institutions. In fact, it is doubtful if it could have taken place without such a concerted effort. Indeed, the most important elements in the process can be summed up as follows. The role of the national government was to provide a broad framework to force the regional municipalities and cities to draw up strategic plans and to put these into effect in conjunction with their partners. Vital for the development of technical expertise and knowhow were the university, VTT and Tekes. With the interaction of these players, a development path was set along which modern industry could travel and thrive on a route where growth, was no longer predicated simply on natural resources but, could support itself firmly on what can be termed a knowledge based economy. However, as will be discussed in subsequent chapters, centre stage in the whole process was to be taken eventually by Nokia, not only in encouraging technology development, but in generating employment through which its activities became embedded in the local economy.

5 NOKIA

INTRODUCTION

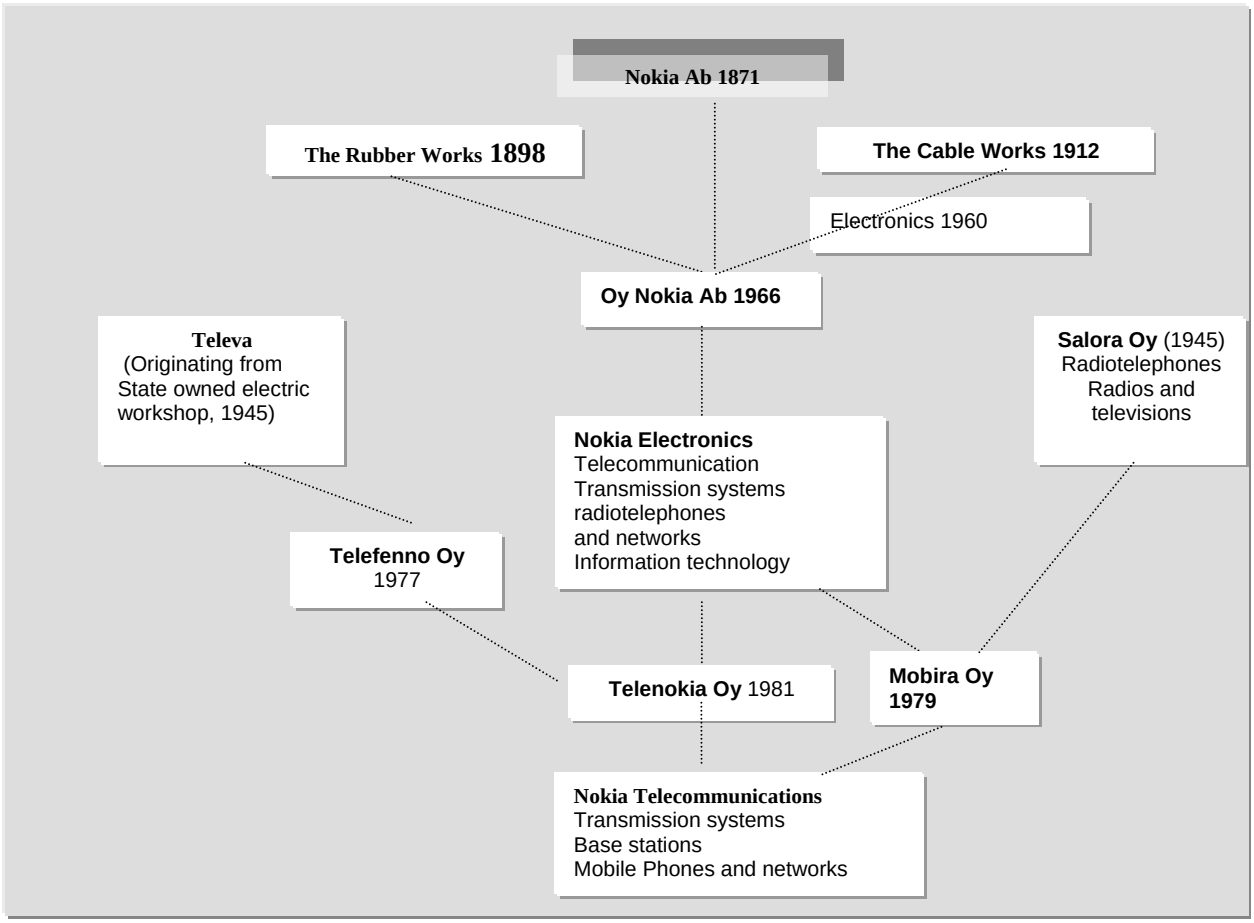
Nokia has played a very significant role in the Finnish economy generally and in the Oulu Region since 1970. Nokia's evolution from a company involved in traditional industries into one of the global leaders in the 1990s in the telecommunication industry strongly influenced the new technology based industry development taking place in the Oulu Region. This process is considered in the first part of the chapter with the latter part focusing more firmly on its acitivites in Northern Ostrobothnia. Nokia is, at the time of writing this thesis, one of the global giants in telecommunications and a market leader in mobile phones. To achieve this position the former multi-industry company has undergone many changes. Its consolidation in the market took place in the early 1990s, and during that decade Nokia grew in terms of turnover, number of employees at home and abroad and in exports. This was a reversal of its position in the early 1990s when it struggled in the consumer electronics industry and found itself having to exit that sector to concentrate on telecommunications and related industries. Finally, this chapter concentrates entirely on Nokia's own development process and its relationships with other firms in the Oulu area are reserved to the subsequent chapter where their relevance is more immmediate.

Nokia has been in the Oulu Region since 1960 where it manufactured electric cables and in 1972 it expanded its activites by entering the electronics industry. Nokia has had a changing role in the development of Oulu. Until the mid 1980s, Nokia's operations were not strongly linked to the university or the city of Oulu. The rise of the telecommunications industry, initiated by the emergence of the NMT cellular network, changed the local business environment and Nokia's subsequent growth in this area was partly due to its acquisition of several local firms which at that time were firms more actively involved in the telecommunications industry, and it is from that point that Nokia began to exercise the function of an anchor firm through its relations with the NTBFs (Häikiö, 2001;Oksman, 2002).

5.1 Nokia; from Conglomerate to Telecommunications Company

Nokia`s roots, as illustrated in Figure 5.1, arise from the establishment of three separate companies and the incidence of their individual development paths (Häikiö, 2001; Nokia History).

Figure 5.1 The development path of Nokia



Sources: Häikiö, 2001; Nokia History, 2003; Mäkinen, 1995

The initial companies were:

- Nokia Ab, established in 1871 operated first in pulp and later in the paper industry and power generation;
- Suomen Gummitehdas Osakeyhtiö (The Finnish Rubber Works), established in 1898 and operated in the rubber processing industry; and
- Suomen Punomotehdas Oy (later Suomen Kaapelitehdas/ the Finnish Cable Works), established in 1912 and operated in cable manufacturing.

The oldest of the firms, Nokia Ab, was established on the Nokia river, from where the name came. At the beginning of the 1880s, Nokia Ab invested in two paper machines and produced brown wrapping paper and coloured wallpaper. The production of paper consumed a lot of energy and Nokia Ab then invested in power generation in 1900 (the Finnish Rubber Works was one of the first major customers of Nokia Ab's power plants). Nokia Ab never enjoyed a high domestic market share in the paper industry, but did so in the wider European market and it remained the most international of Nokia's businesses until the telecommunications developed in the 1990s. Nokia Ab was especially successful in markets such as the USA, Britain and France and in 1972, Oy Nokia Ab became a shareowner of British Tissues Ltd jointly with G.A. Serlachius Oy, and later bought out all the shares in 1979 (Häikiö, 2001; Nokia History, 2003). However, between 1989 and 1991 Oy Nokia Ab disposed of its paper and power generation concerns to concentrate on its telecommunication activities.

In 1918 the Finnish Rubber Works acquired a controlling interest in Nokia Ab and later in 1922 a controlling interest in The Finnish Cable Works and so a concern was born with one major owner. The companies continued to carry on their businesses as independent companies until 1966, when two of the companies, The Finnish Rubber Works and The Finnish Cable Works, merged into Nokia Ab. The new company, Oy Nokia Ab started operations in January 1967. Oy Nokia Ab then incorporated the following industries: forestry, power generation, rubber, cable and electronics. An experimental new business area, electronics, was started as a new department in the Finnish Cable Mill in 1960 (Häikiö 2001, Nokia History).

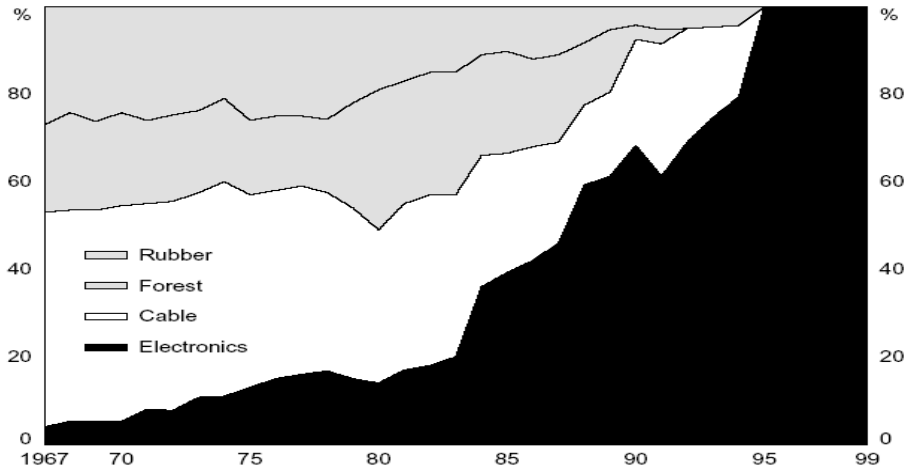
When the Rubber Works began in 1898, its first years were difficult. Losses were endured and there was no consensus among the shareholders about how the company should be run. The first products were rubber shoes, boots and overshoes. World War I, however, changed the situation when the import of rubber products from Russia stopped, which allowed the Finnish Rubber Works to gain the market leadership in Finland and improve its economic performance. At the end of the war, the Rubber Works acquired the controlling interest of Nokia Ab in 1918 in an attempt to ensure energy supply for the rubber factory. The reason for acquiring a controlling interest of the Cable Works in 1922 was the need for rubber as an insulating component for cables. The Rubber Works was fully incorporated into Oy Nokia Ab in 1967 and since then mainly focused on its domestic market, and exporting footwear and tyres and technical rubber products to nearby Nordic countries and Germany (Häikiö, 2001; Nokia History, 2003).

From the 1920s onwards, the Cable Works was the part of the business linked most closely to the electrification and construction of the telephone networks in Finland and almost succeeded in achieving a monopoly of the Finnish market in telephone cables throughout the inter-war period.

After World War II, Finland had to pay the Soviet Union a considerable amount of financial compensation as war reparations between 1945 – 1952. The Cable Works got 5.7 % share of these reparations and this trade with the Soviet Union became very important in the 1950s and 1960s as it represented nearly 25 % of its total exports. Co-operation with the Soviet Union continued to grow in the 1970s to compensate for the increase in oil prices which necessitated increased exports to the Soviet Union to keep trade in balance. Similarly, as cable manufacturing technology expanded generally in the economy, Nokia expanded its market share by acquiring firms, such as the Swiss company Maillefer in 1987, and became a global market leader in this field. In the early 1990s, the collapse of the Soviet Union coincided with the recession in Finland and changed the situation again. Nokia then found itself being forced to focus more on telecommunications and sold its cable industry to a Dutch Cable manufacturer, NFK. It should be noted that in the early nineties, alongside other Finnish companies, Nokia experienced serious financial difficulties and had to sell off assets to allow it to continue to operate.

The cable business was Nokia's most profitable business until 1991; it had also been the incubator unit for the up-and-coming electronics industry since 1960. In the overall development path of Nokia, the role of the cable business has been paramount. Indeed, the development of the electronics business would not have been possible without the cable business (Häikiö, 2001; Nokia History, 2003). Figure 5.2 shows the structural changes in Nokia between the years 1967 – 1998. When Oy Nokia Ab was formed in 1967, cables were the dominant product whereas electronics formed only a small percentage of the overall operations. By the mid 1980s, the position had been reversed and electronics had overtaken as the dominant sector.

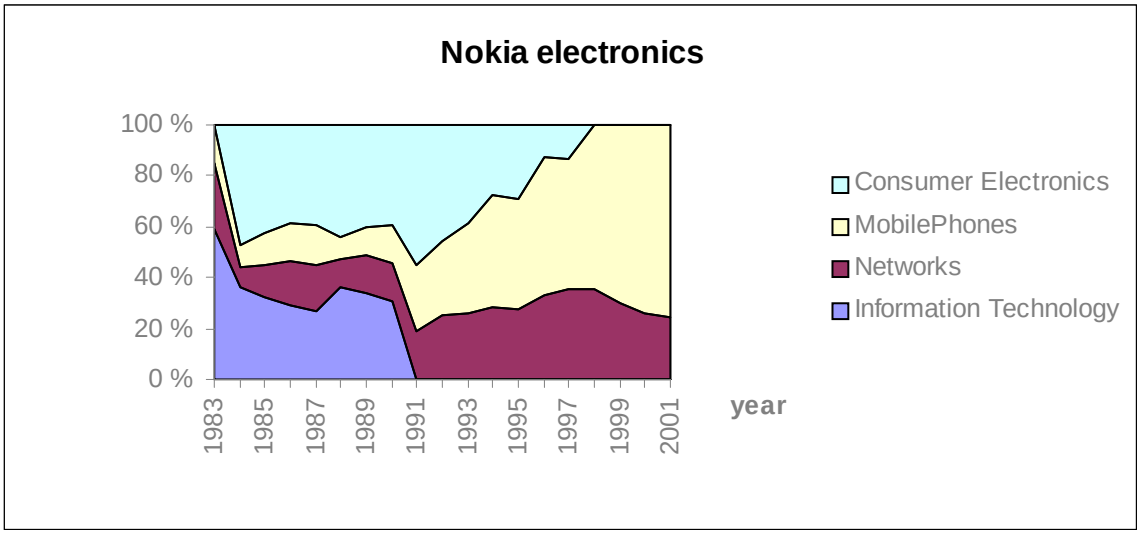
Figure 5.2 Sales of Nokia by industrial group (%)



Source: Ali-Yrkkö et al, 2001; Lemola and Lovio, 1996

The structural changes in Nokia electronics' output are more clearly demonstrated in Figure 5.3, in which the share of the different aspects of the business is disaggregated.

Figure 5.3 Sales of electronics industry in Nokia divided into the main categories between the years 1983 – 2001 (%)



Source: Annual Reports, 1983 – 2001

Until 1990, the dominant businesses in electronics were information technology and consumer electronics. Information technology was divested in 1991 and the percentage of consumer electronics increased until 1998. Since then Nokia has concentrated on telecommunication networks and mobile phones.

As discussed above, in 1967, Nokia's constitutent parts were merged into one group, known as Oy Nokia Ab. As part of this, Nokia Electronics has operated in several sectors since its establishment. After its early start in the electronics business through the importation of computers since the 1960s, Nokia Electronics actively extended its business to the manufacture of microcomputers of which it became the major manufacturer in the Nordic Countries by the 1980s. To facilitate this, Nokia Electronics bought the microcomputer industry from Ericsson of Sweden, in 1988 and then in 1990 sold this to ICL as it disposed of a range of assets to raise much needed capital ((Häikiö, 2001; Nokia History).

In the 1980s, consumer electronics was a focal area for Nokia Electronics and the company was actively engaged in acquiring television factories throughout Europe. In the late 1980s, it had become the third biggest television manufacturer in Europe after Philips of Holland and Thomson of France. However, this industry proved unprofitable and led to massive losses of 7 billion FIM causing financial uncertainty for the whole company. In consequence and to alleviate the situation at the beginning of the 1990s, the major holdings in the television industry were sold off except for the production of TV monitors, which in turn were later disposed of at the end of the decade (Häikiö, 2001).

Telecommunications evolves into a dominant industry of Oy Nokia Ab

In the 1960s, telecommunications was one part of the small and experimental electronics group, which was part of Nokia`s Cable Works. At that time the business culture in the Cable Works was more focused on new technology and new experiments rather than either the rubber or paper activities.

It was not until the following decade that investment in the telecommunications sector gained a higher level of visibility. This expressed itself in the development of advanced PCM[9] transmission systems and later in new, digital exchange (switching) technology which was to prove a critical steps towards the latter success in that sector (Häikiö, 2001; Nokia History, 2003; Mäkinen, 1995).

[9] PCM= Pulse Code Modulation

The first transmission system for a fixed telecommunication network based on the new PCM-technology was delivered to the Soviet Union which was a demanding *"test-market,"* and after some technical problems in the early deliveries, Nokia Electronics learned to build transmission systems for a fixed telecommunication network using digital technologies (Mäkinen, 1995). Moreover, Nokia also delivered radiotelephone systems to the soviet oil and gas industries.

In the 1970s, the Finnish government was also involved in the electronics industry through the state owned the company, Televa, which at that time was developing and manufacturing exchanges (switchboard systems) for the Finnish army and other national teleoperators. Televa started a massive development project at the end of the 1960s to develop a digital exchange[10] system. Televa was essentially a very small firm compared to its competitors, Ericsson, Alcatel and Siemens, and its resources for this development project were too small (Häikiö, 2001; Nokia History, 2003; Mäkinen 1995). Nokia, too, had an interest in pursuing ths type of technology and had a licence from the French firm, Alcatel, to use it. Eventually in 1977 Televa and Nokia joined forces and formed a joint venture, Telefenno to pursue the development of the DX200 digital exchange technology. Some years later Televa fell into financial difficulties and had little option but to sell its holdings in Telefenno to Nokia (Häikiö 2001, Mäkinen 1995). The development work for DX200 system remains the largest software development project ever undertaken in Finland and is still ongoing. This has allowed Nokia Electronics to acquire the know-how in both transmission and digital exchange technologies and so strengthen its position in the Finnish and European telecommunications sector (Mäkinen, 1995; Häikiö, 2001; Väänänen 2002).

In Finland in the 1970s, the radio and television industries were thriving in firms such as Salora and Finlux. Salora also operated in the radiotelephone business and was at the time the national market leader. Nokia and Salora were competitors in that small market, which consisted of closed radio networks for special purposes and later a national open network, which was manually connected to a fixed telenetwork (ARP[11] (Mäkinen, 1995; Häikiö, 2001; Väänänen, 2002; Nokia History, 2003). Moving from being national competitors, Nokia and Salora started co-operation in 1979 by establishing a joint company, Mobira Oy, to develop the mobile phone business. One impetus for this was the Nordic NMT[12] Mobil network and the increasing levels of market

[10] In digital exchange the computers replaced the electromechanical relays
[11] ARP was the first national cellular network in Finland
[12] NMT (Nordisk Mobil Telefon) was the first Scandinavian-wide cellular network using digital exchanges and analog

competition. In this NMT network Nokia, along with its Swedish competitor, Ericsson, was able to develop its subsequent expertise in cellular mobile phone systems.

Nokia in the 1990s

When the Finnish economy fell into recession in the 1990s, Nokia was not immune from this. At the time ten of Finland´s leading banks[13] were major shareholders in the firm and they, too, suffered in the ensuing financial debacle. Questions were raised about the consequences of the financial collapse and above all how this would have an impact on the ownership of Nokia, which was after all the country´s leading firm. In the event Nokia managed to weather the storm and continue its development in the telecommunications business due to its fast growing GSM[14] technology.

In 1994 Nokia`s board defined its main strategy as follows: "*to benefit from the growth potential in the telecommunications sector by investing heavily in the development of the telecommunications and mobile phone industries on the basic of organic growth"* (Häikiö, 2001). This decision had far reaching consequences in that the company embarked on the decisive road from being a multi-brand organisation to a brand building company focusing almost exclusively on telecommunications which had repercussions for its activites in Oulu.

5.2 Nokia in Oulu

Nokia started its activities in Oulu in 1960, when Pohjolan Kaapeli Oy was established (a subsidiary of Cable Works) which became market leader in the cable market in Northern Finland. The cable industry for a long time dominated the electro-technical industry in the Oulu Region. In 1972, Pohjolan Kaapeli Oy moved its manufacturing activities from the city center in Oulu to new industrial premises located in a suburb of Oulu city - known as Rusko - which later became one of the key areas for the development of Nokia in Oulu. In the 1970s and early 1980s, the manufacture of cables increased dramatically and the product scale extended from cables for the electro technical and telecommunication industries, into wiring harnesses for the car industry in 1969.

radio signals (1.generation /HS Kuukausiliite, kesäkuu 1999), opened in 1981 (Häikiö, 2001).

[13] Yhdyspankki and owners close it owned 30,66 %, Kansallispankki and owners close it owned 24,45 % in 22.2.1990 (Haikiö 2001)

[14] GSM (Groupe Special`Mobile) European wide digital cellular network; first opened 1.7. 1991

In 1986 Nokia acquired another Oulu cable manufacturer, Suomen Kaapeliteollisuus Oy, and merged its activites with the original Nokia cable works in the city A third entity was formed in 1990s when a new firm, Nokia Johdinsarjat, was spun off to specialise in wiring harnesses for cars.

Though these moves consolidated Nokia`s activites in cable production in Oulu, the venture was soon abandoned. They occurred just at the time when Nokia began to concentrate more on the telecommunications industry in the 1990s and as a consequence the cable interests were sold off. Nokia Johdinsarjat Oy was sold in 1994 by MBO (Management Buy Out) to the management of the firm and continued under the name of PK Cables Oy, which later branched into the telecommunications industry, was listed on the Helsinki Stock Exchange in 1997 and employed 450 people in the Oulu Region in 2001. The rest of the cable interests in Oulu were sold in 1995 to NKF Holding which in 1997 changed its name to NK Cables, and still employs approximately 500 people in the Oulu Region (Nokia History, 2003; Annual Reports of PKC Group, 1996-2002).

As mentioned previously, Nokia Electronics started its activities in Oulu in 1972, when the company received an order from the army for the production of radios based on an American licence. In 1974 the production of radiotelephones for civilian purposes started in Oulu. One of the Finnish pioneers in the radiotelephone industry, Lauri Kuokkanen, came with his team from Nokia Electronics in Helsinki to Oulu in order to set up the manufacturing of base stations for radiotelephone networks. The radiotelephone networks at that time were special networks for industries or state and local authorities and national open ARP networks (Vilmi, 2002). The production and development work for base stations commenced in Oulu in 1975. The main reasons for moving the telecommunications activities from Helsinki to Oulu are said to be as follows (Oksman, 2002):

- a lack of premises for the growing electronics industry in Helsinki;
- the culture of the growing telecommunications industry differed from the other electronics industries in Nokia;
- the high turnover of workers in manufacturing in Helsinki;
- a suitable premises was available in Oulu;
- some tax benefits for starting activities in developing regions of that time;
- lower wages in Oulu.

At the end of the 1970s, aside from the development of base-stations in Oulu, other devices were being produced such as beepers for contacting people via tele networks and portable mobile phones for the local authorities. This device was not particularly successful and the mobile phone business for local authorities was moved in 1982 to Äänekoski, a city 300 kilometres south of Oulu, where Nokia also had activities arising from its earlier acquisition of Televa (Vilmi, 2002).

When the mobile phone development and production of Nokia and Salora merged in 1979, their joint venture company, Mobira, took over the development and production of mobile phones (ARP and later NMT) from Nokia Electronics and the mobile phone business moved to Salo in Southern Finland. Therefore, at the beginning of the 1980s, Nokia Electronics in Oulu was left to concentrate on the development and manufacture of base stations and transmission units (Jokinen, 2002; Vilmi, 2002).

The NMT [15]standards for Nordic telecommunication cellular networks were drawn up in the late 1970s. To accommodate these, Nokia Electronics began the planning of base stations for NMT networks in 1979 with deliveries of base stations, including transmission systems, starting in 1982. Customers for the Oulu product included Finland`s Sonera and Sweden´s Telia, for example, and gave employment to 374 people in Oulu. Production of the actual mobile phone units was carried out in Salo rather than in Oulu. A shortage of production space in Oulu caused the manufacturing of transmission systems to be moved to a new industrial park at Haukipudas some 30 kms north of Oulu in 1985 and gave employment to approximately 1,000 employees, which included a dozen or so people employed in a small research unit (Vilmi, 2002).

New activities in Oulu

In the mid 80s, the role of Oulu in Nokia Electronics started to strengthen. One remarkable event was the expansion of R&D in digital exchange technologies (DX200) based at Telenokia in Oulu, and another was the establishment of an R&D unit in Mobira in Oulu - both developments took place in 1985.

The reason for bringing the R&D of Telenokia to Oulu was the lack of an adequately trained workforce in the Helsinki region. The R&D work was predominantly in the development of software and Oulu started to look attractive due to the resources available. This development work

[15] Other standards were e.g. AMPS in USA, TACS in United Kingdom and NTT in Japan (Ojanperä et al, 1998)

in Oulu raised the number of employees in the unit to 350 people. The main focus lay in specializing in the applications of DX200 in fixed telecommunication networks. As noted earlier, the applications for mobile networks were done elsewhere. This activity in Oulu continued until the year 2000, when Nokia defined it as a "*support activity*" (i.e. not the core business), and declared that future mainstream development in Oulu would be in mobile rather than in fixed technology. As a result, the development of DX200 was outsourced to Tietoenator Oy (Väänänen, 2002; Vilmi, 2002; Nokia press release 2002).

As shown earlier, the prime responsibility for the development and production of mobile phones shifted to Salo at the beginning of the 1980s, but in 1985 product research and development for these was resumed in Oulu. Initially this concentrated on the development of software for mobile phones (DSP, digital signal processing) and later in 1986, it extended to integrated circuit design and, finally, in 1988 to hardware design. In other words, Oulu was gradually gaining the capacity to design and develop cellular phones. Eventually the development unit in Oulu began to take more responsibility and prominence in the whole company in the development of software and integrated circuits and also in the design of special products. The first mobile phone fully designed in Oulu was the NMT 450 mobile phone tailored for France Telecom in 1989 (Jokinen, 2002; Vilmi, 2002; Väänänen, 2002).

The 1990s: new challenges

Base stations:

The European standards for digital mobile phone systems (GSM)[16] were created in the late 1980s. Nokia played a significant role in this standardisation process and Oulu was given the responsibility for the development of base stations for GSM[17] networks. The development logic for the development of GSM base stations followed the line of development of NMT base stations. In order to develop the base stations, a new consortium, ECR 900, was established. The members of this multinational consortium were AEG of Germany, Alcatel of France and Nokia. The development of a base station for the GSM network was split into parts, each of which were then developed by the members of the consortium. The main aim of this consortium and for Nokia was

[16] Other 2nd generation standards were US-TDMA in 1989 and IS- 95 in 1995 in the USA and PDC in Japan in 1990 (Ojanperä et at, 1998)
[17] The first phone call by using new GSM technology was done in Finland 1st July. 1991 (Jokinen, 2002)

to learn about and implement the new standards and technology. The deliveries of base stations started in 1991 and Nokia took advantage of this experience to further invest in, upgrade its know-how and improve the quality of its own products.which were duly launched in 1992 (Vilmi, 2002; Väänänen, 2002).

GSM took off quickly and the strategy in Oulu in the 1990s was designed to meet a rising demand not only locally, but also overseas with a sharp increase in the manufacture of base stations. Oulu´s output was unable to cope with the demand and so it was decided to set up subsidiaries abroad. Fast growth led to the establishment of a plant in the U.K in 1990. The reasons for this expansion were twofold, on the one hand, a shortage of people capable of meeting the rising R&D demands and, on the other hand, the prospect of improved access to the British market by having a physical presence there.

Further afield, the Chinese market opened up to overseas telecommunication firms in the 1990s as China´s economy attempted to modernise. Such a potentially vast market proved attractive to Nokia and two base station manufacturing facilities were opened there, one being a wholly owned subsidiary and the other a joint venture. Turning westwards, Nokia succeeded in penetrating the difficult US market following deregulation of the industry and in 1996 a plant was opened in Dallas, Texas. This venture proved somewhat unsuccessful and after a few years production was switched to the much more lucrative mobile phone market. At the time of writing, Nokia now has operations in 37 countries through joint ventures and strategic alliances (Nokia, 2002).

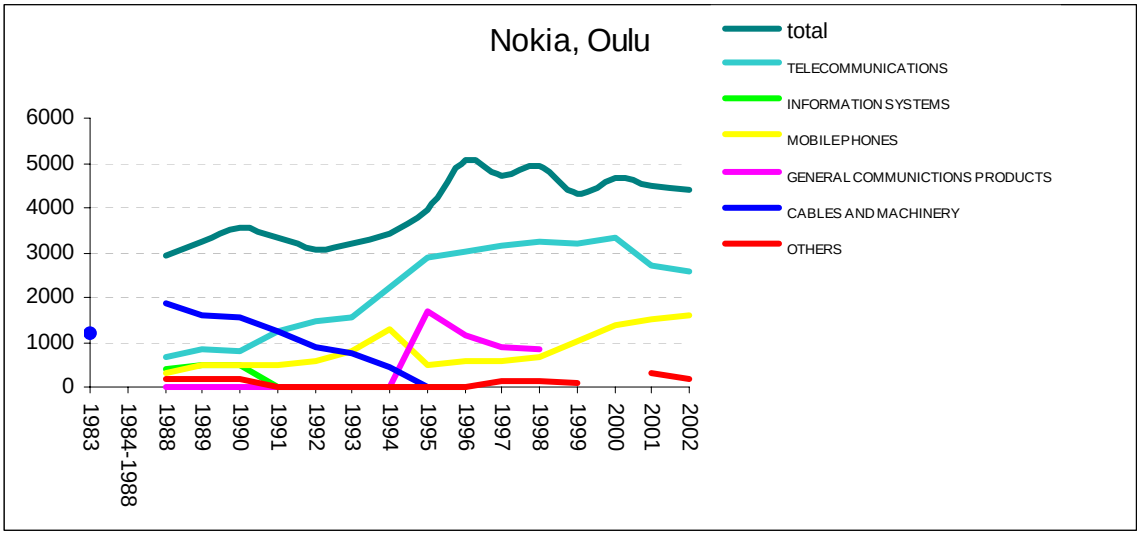
Mobile Phones in Oulu in the 1990s

Nokia Mobile Phones in the Oulu Region in the 1990s has been purely an R&D unit concentrating on product development, the development of design, manufacturing and testing technology for these products. The term used in the Oulu unit of Nokia is “the product creation centre”, which includes all the activities needed to develop a new product, other than manufacturing itself.
In Nokia as a whole, the development done in Oulu has a very focal position. The responsibilities at company level in Oulu have been the development of the mobile phone for the US market (TDMA). Also from its establishment in 1986, Oulu has been involved in key technological areas, such as software for mobile phones, integrated circuits and digital signal processing.

In Finland the development of mobile phones is located in Oulu, Salo and Tampere. All of these units have their own unique profile and the strength of Oulu is in digital signal processing, which is fundamentally important in digital mobile phones (i.e. GSM; TDMA; WCDMA[18]) and is also strongly linked to the research and education available in Oulu in VTT, the university and the polytechnic.

At the end of the 1990s, Nokia as a company and also Nokia in Oulu were growing fast. All the jobs in mobile phones in Oulu were in development activities, with even the base station turning increasingly to developmental work rather than relying solely on manufacturing activities. In 1997 about 300 of the jobs in the base station unit were in development, and by 2000 the number of jobs had risen to about 850. Additionally, new development units were established, one in Raahe employing about 50 people (2002) and another in Kemi (employing 20 people 2001). Eventually in 2001 all of the base station R&D work in Kemi had been outsourced to Elektrobit Oy which by that time had taken over the Kemi unit. Figure 5.4 demonstrates the clearly shifting pattern of employment in Nokia throughout the Oulu Region as the firms priorities changed over time.

Figure 5.4 The development of jobs in each of the Nokia industries in the Oulu Region



Source: Nokia, 2002

[18] WCDMA Wideband Code-Division Multiple-Access (W-CDMA) is one of the main technologies for the implementation of third-generation (3G) cellular systems (http://www.umtsworld.com/technology). (See also Holma et al, 2000).

As the above Figure shows, the total numbers employed by Nokia peaked at around 5,000 between 1996-97, before falling back to stabilise at approximately 4,500. There have been many major shifts during that time. In 1980s, the biggest sector in Nokia in the Oulu Region was the cable industry but this was sold off in 1995. The telecommunications sector then became the dominant sector with employment peaking at the end of the 90s at just over 3,000 before falling back in the early 2000s. In recent years the fastest growth element has been in mobile phones where the numbers have expanded steadily from 1996 onwards. Finally, at the time of writing, Nokia employment is at approximately 4,000 operatives in the Oulu Region.

5.3 Conclusions

When analysing the development of Nokia in Oulu it is clear that the firm has gone through several re-incarnations in response to the developmental shifts in technology. After the manufacture of cables and then of base stations, the emphasis has been primarily on R&D activies, often in concert with local institutions. However, in discussing Nokia in Oulu, it is necessary to distinguish the two different development paths, one in base stations and the other in mobile phones. Although they are strongly linked, they represent different sectors of the same industry (Nokia Networks and Nokia Mobile Phones) and their history and position in the Oulu Region deviate. Nokia Networks has a longer history in the region, and has been more influential as a job provider. However, at the beginning of 2000, both industries were similar in size, with about 2,000 employees each. Clearly, Nokia overall has been beneficial for jobs as its Oulu operations jointly account for approximately 8% of all Nokia employment in Finland, and thus makes it a major contributor to the vitality of the economy of Northern Ostrobothnia.

6 Industrial Development in Technology Firms in the Oulu Region between 1970 - 2002

INTRODUCTION

This chapter investigates the development of firms in high technology industries in the Oulu Region during the period of observation, 1970 – 2002. The main technologies, discussed are telecommunications, software and electronics, which are the dominant technologies in the Oulu Region. Other technologies, like biotechnology, are looked at briefly. Most emphasis is on the 1990s, because in that decade the industrial development has been more powerful and the material for analysis is much more comprehensive than for the previous decades. As demonstrated in Chapter 4, the industrial conversion from the traditional industries to a centre of new technology based industries has taken place in a series of stages. The early stage (known as the Formative Stage) was more or less the pioneer work pursued by Professors Oksman and Otala in the University of Oulu. The new industrializing paradigm was influenced by the example of Silicon Valley and Scotland. The emerging electronics industry in Northern Finland sprouted initially from the firms in the traditional industries. For example, as illustrated earlier, Kajaani Oy started a department, Kajaani Electronics, which was similar in concept to the one Nokia had started earlier in the Helsinki area (Nokia Electronics). The establishment of Kajaani Electronics, in fact, opened a development path for the many firms currently located in the Oulu Region as a result.

The arrival of Nokia Electronics to the Oulu Region in 1972 was one of the critical events for subsequent activities, which led to the swift growth of the telecommunications industry in the Oulu Region as examined in Chapter 5. This chapter focuses more on the development of various industrial groups of smaller firms which make up the overall regional cluster.

The perception in the 1970s was that Northern Finland could be a manufacturing place for the growing electronics industry, and at that time there was a growing regional demand for jobs for women as postulated initially by Otala in the early 1970s. One, and the only, example of this kind of industrialization was the setting up of a manufacturing plant in electro mechanics by LM Ericsson of Sweden in Raahe (the male population in Raahe at that time were still able to find employment mainly in the local steel mill). One reason for starting this was the availability of a female workforce in Raahe, but another potential reason was the building of its image as a

"Finnish" firm in order to strengthen its position in the Finnish telecommunication market and also in the Soviet Union in which Nokia Electronics and other Finnish firms were strongly involved (Häikiö 2001). The plant in Raahe was based on older technology, but had little success, causing it to be closed down in the late 1980s. A new company, TH Elektroniikka[19], was then founded in Raahe to provide subcontracting services for consumer electronics for Nokia. The plant is now (in 2003) a unit of the PKC Group.

As the traditional industries had been diversifying since the 1970s, the behaviour of those firms started to change in the latter part of the 1980s. The companies started to focus purely on the core businesses and give up subsidiary ones. Their pathways differed. For example, Kajaani Oy and Rautaruukki Oy started to sell out their new technology businesses. Nokia took the opposite direction. Nokia was a company with several industries and it started to sell off its traditional interests to concentrate more on the emerging new technology. The result of the activities of Kajaani Oy and Rautaruukki Oy in new measurement technologies in steel making can now be seen in several firms still operating in the Oulu Region (e.g. Buscom Oy, Jutel Oy, Idesco Oy).

Prior to examing the various groups that comprise the overall cluster of the NTBSs in Oulu and Ostrobothnia, it is more than useful to draw on what has already been written so far and so help contextualise the discussion to follow. The milieu in which these firms functioned was, though geographically remote, highly innovative. It was an area of extremely scarce and delicate natural resources in the 1960s and 1970s. Moreover, it was generally recognised at both national and local levels that if Northern Ostrobothnia were to develop economically then, any future industrial growth would have to be predicated on emerging knowledge industries. Such a paradigm shift called for innovative people with high levels of education in relevant skills, who were capable of both individual and teamwork to which they could contribute energy and enthusiasm and exhibit a desire to learn as well to participate in both formal and informal training to upgrade their skills and competences. Working in this kind of environment called for vision, a willingness to innovate and leadership qualities. Fundamentally, this type of development is not simply about structures, but requires a specific culture or mental state that can often be self-reinforcing (McCloughlin, 1998).

NTBFs are essentially quite a specific group of firms and are usually formed by highly technologically educated personnel, aged between 30 and 40 years old who have had between ten to fifteen years work experience in a certain speciality. Many of these founding entrepreneurs may be

[19] This opinion is based on the author's co-operation in the Raahe Region during that time

drawn from a unique area where they have built up friendships with others of their ilk through attending the same or at least the same type of educational establishments, and share either a common culture or belief. The early start-up capital required varies across the sector. For example, software firms are cheaper to fund than those in biotechnology sciences. Moreover, often such firms are located, as American experience has shown, close to universities or specialist research laboratories where support services can be obtained readily (Breschi and Malerba, 2001; Wolfe, 2003). It should be stressed also that in many cases, NTBFs focus more closely on product rather than process development and often watch their business grow primarily through reinvested profits or in some cases taking over other concerns. As mentioned earlier, external linkages are important to them either through relationships with institutions or with their clientele which can be positive but, on the other hand, over-dependency on a narrow range of clients either as customers or suppliers may have a stultifying effect on development which may lead to longer term vulnerability.

Turning to the Oulu experience, research has shown that many of the small firms fit quite well into the categories described above. With some exceptions, almost all of the founders of their firms hail from Oulu and Northern Finland with Lutheranism being the most common linking religious and cultural background. Indeed, over 90% of Northern Finns would describe themselves as basically Lutheran and also display a very strong sense of identity with and loyalty to their region (Hannula, 2002). Moreover, it has been estimated that between 1982 and 1992 just over 50% of founding entrepreneurs were graduates of the University of Oulu's Faculty of Engineering (Oulu Business Review). Since then, this situation has changed somewhat with more and more graduates from the Polytechnic of Oulu setting up on their own (Paloniemi, 1991; OBR, 2002). Furthermore, there have been a number of spin-offs for the university and VTT. Ten spin-outs have come from the university's Biotechnology Research Centre and, at the time of writing, the university is in the process of formulating its approach to the regulation of spin-offs (Infotech Report, 2002; BioCenter Report, 2002)

Most firms were initially small and self-funded and consisted of only a few employees. Elektrobit Oy, for example, was set up by Juha Hulkko, graduate of the local university, in 1985. Further growth and expansion came primarily from retained earnings and this appears to have been the norm for firms in the area (Elektrobit, 2000; Matilainen et al, 1999). External funding, in the form of venture capital, was very late in arriving to Oulu and came mainly from Helsinki. A good example of this, however, is the software developer, Nethawk, one of the area's most successful firms (Ahokangas and Pihkala, 2002). Development by take-over has been rare. However, one

example of this occurred when Polar Electro – to be discussed later – took over Buscom Oy and Idesco to gain access to their sensor technologies to add to their own expertise in this field and so increase synergies (Marttila, 2000). In contrast the failure rate among the small firms has been small. The majority have managed to survive for ten years or more, although why this has happened as yet remains unclear. This area needs a little more clarification. Many of the surviving firms have shifted their field of expertise over time to take account of change and the swift pace of development in technology. Indeed, some have simply changed their names to reflect their new orientation, which can cause difficulties when trying to keep track of the firms (OBR, 2002).

In the light of the above discussion, it is clear that the various groups of firms in Northern Ostrobothnia are tightly knit and share a reasonably common culture which can be said to have been reinforced by their close proximity to each other in Oulu itself, to the university, to the polytechnic and the fact that physical transport by road and air connections in the area is good and obviously reinforced by excellent ICT facilities. Such proximity and personal relations have perhaps facilitated the relations between firms in the areas of outsourcing and subcontracting which in turn have been reinforced by informal networking among firms through the monitoring of each other's activites or the exchange of tacit information. The combined roles of the university, VTT and Technopolis should not be underestimated as cementing factors in the growth and development of cooperation and networking. Indeed, the various related fora, such as the Mobile Forum and the Software Forum, are examples of these features at work (Similä, 2002).

6.1 The Growth of Firms

As touched on earlier, the number of NTBFs grew rapidly in the Oulu Region between 1980 and 2002 as did the increase in jobs (Table 6.1). The main sectors represented in these figures are telecommunications, computer software products and services and, to a lesser degree, biotechnology.

Table 6.1 The development of jobs and number of business units 1983 – 2001

Year	Jobs	Business units
1983	2620	32
1985	3497	85
1990	4146	123
1995	4860	196
2001	10199	247

Sources: Statistics Finland, 2002; OBR 2002

By the year 2001, the dominant industries were telecommunications and software. Telecommunications employed 7,373 people (72 % of the total), in 37 business units (15 % of the total), and the software industry employed 1,427 people (14 % of the total) in 147 business units (60 % of the total). The cable manufacturing in Pohjolan Kaapeli Oy (owned by Nokia) was significant up to the beginning of 1990 with more than 1,000 jobs, but since then this figure has decreased to 500.

When the Oulu Business Review was created in 1991, it defined the regional technological profile. The Oulu Business Review reviewed the development in the main technological areas; telecommunications, software, electronics and other technologies (like bio-technologies). In this first preliminary analysis, 65 of those firms were interviewed. The research indicated that this sample represented approximately 90 % of all firms and employees in high technology industry in the Oulu Region (Paloniemi, 1991).

In 1991, the profile of the 65 firms(units) from an organisational profile perspective was as follows:

- software 18 (28 %)
- telecommunications 15 (23 %)
- electronics 12 (18 %)
- other 20 (31 %)

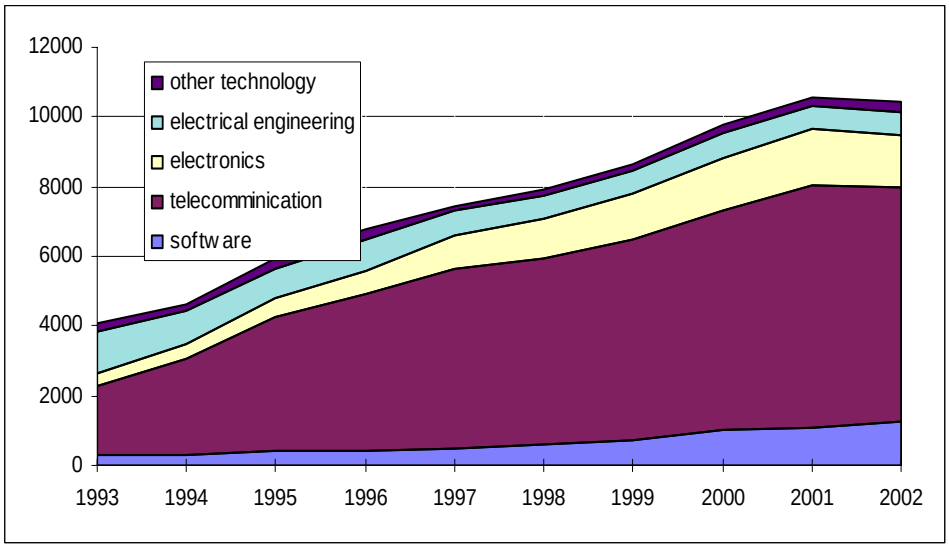
Software included the development and production of software, software subcontracting, embedded software and data processing systems (hardware and software).
Telecommunications included the development and production of radio systems, mobile phones, base stations, exchanges and transmission equipment.

Other electronics included the development and production of electronic measurement systems (like optoelectronics, heart rate monitoring, fare collecting systems, radio tracking and telemetry devices) and components for the electronics industry.
Others included process automation, the electro mechanical industry and biotechnology.

The rate of establishment of new high technology firms in the region increased rapidly from the l980s onwards, of which 71 % were categorised as SMEs. In contrast, most job creation took place in the units or subsidiaries of larger firms such as Nokia and Kajaani Oy. With regard to financial turnover, the share of SMEs was only 20 %, whereas the firms or units or subsidiaries of the larger concerns accounting for the other 80%. Similarly, the SME share of exports was a mere 5 % of the total, leaving the other 95% in the hands of the major entities. In other words, this data further confirms the important role played by the larger anchor firms in the Oulu Phenomonon. However, this dominance should not be exaggerated too much, if only because the importance of the interaction between the likes of Nokia and the smaller concerns in effecting development.

Figure 6.1 demonstrates the proportional development of jobs in the dominating sectors in the years 1992 –2002.

Figure 6.1 Sectoral Division of Jobs in Technology- Based Firms in the Oulu Region 1993-2002



Source: OBR, 2002

From this it is clear that in the 1990s, the number of jobs increased from roughly 4,000 to more than 10,000 and, at the same period, the industrial structure changed with the telecommunications industry becoming the leading sector.

6.2 The industrial development in the Oulu Region during the years 1993 -2002: three main technology groups, 18 firms

When examining the industrial development in the Oulu Region more in depth, it is possible to analyse each of the main technology sectors by following certain firms and their ongoing development indicators. Consequently, the next part follows the development of 18 firms in the Oulu Region between 1993 - 2001. These 18 firms can be divided into three groups, which are:

- telecommunications (8 firms)
- software engineering (5 firms)
- other electronics firms (5 firms).

This sample consists of firms, all established before 1992, all operating in 2001 and from whom information was available.

6.2.1The Telecommunications Group

The telecommunications group includes 8 firms. Table 6.2 indicates the years they were established:

Table 6.2 The firms included in the telecommunications group

Firm	Established in Oulu
Nokia Electronics	1972
X-net (Later NetHawk)	1991
Jutron	1990
REMEC Finland Oy (Solitra 1986-1995, Remec Oy 1995-2001)	1986
Filtronic LK (LK-Products 1986-2000)	1978
Elektrobit Oy	1985
JOT Automation Oy (JOT Robotics 1988-2001)	1988
Aspocomp	1972

Source: OBR

This group includes all of Nokia's telecommunications industry in the Oulu Region (except cable manufacturing). These seven plus Nokia firms represent the development and production of components for the telecommunications industry, R&D activities and software intensive products. Table 6.3 presents the progress of these firms in the Oulu Region in terms of numbers of jobs.

Table 6.3 The Development of Jobs between 1993 – 2001 in the Telecommunications Group

	1993	1994	1995	1996	1997	1998	1999	2000	2001
Nokia	1911	2252	2948	4074	3877	4021	4294	4680	4680
Growth Rate (%)		17,8	30,9	38,2	-4,8	3,7	6,8	9,0	0,0
Other 7	800	1057	1457	1661	1856	2039	2210	2134	2128
Growth Rate (%)		32,1	37,8	14,0	11,7	9,9	8,4	-3,4	-0,3
The 8 firms together	2711	3309	4405	5735	5733	6060	6504	6814	6808

Source: OBR

This sample represents more than 80 % of all the jobs in telecommunications in the Oulu Region. Nokia grew until 2000 and also the other firms followed this growth in its wake even if their individual cycles varied.

Table 6.4 The mean size, median size and mean deviation of the telecommunications firms in the sample (not including Nokia) in job numbers

	1993	1994	1995	1996	1997	1998	1999	2000	2001
Mean size	114	151	208	237	265	291	315	305	304
Median size	55	65	95	90	100	120	150	214	325
Mean deviation	116	168	226	230	248	262	248	202	215

Table 6.4 shows the various sizes of telecommunication firms and indicates that the median size of the typical indigenous telecommunications firm rose from 55 in 1993 to 325 in 2001, and reflects an almost continuous expansion in employment. Finally, when analysing the development of telecommunications as a whole, it is necessary to remember to separate the two different development paths in Nokia: telecommunications based on fixed and cellular networks and telecommunications based on mobile phones. Although they are strongly linked, they represent different industries (Nokia Networks and Nokia Mobile Phones) and their history and positions in the Oulu Region deviate as discussed earlier. These firms can be further subdivided into two sections: base stations (Networks) and mobile phones. We now focus on the former.

Base Stations (or Networks)

As Table 6.5 shows the number of jobs based on telecommunication networks in the Oulu Region has continually been growing since the year 1990. This grew rather slowly until the middle of the decade and then increased swiftly in line with the appearance of new firms.

Table 6.5 The number of jobs in Nokia Networks in the Oulu Region.

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
820	1250	1450	1550	2204	2868	3011	3141	3249	3216	3320	2700	2600

Source: Nokia

Nokia Networks includes the development and production of base stations, manufacturing of transmission systems for fixed networks and development of switching systems. In this structure the share of base stations in terms of employment has grown throughout the late 1990s until 2000 before showing a slight drop. Below are three case studies: firstly Lauri Kuokkanen Oy, secondly Elektrobit Oy and thirdly Scanfil whose employment figures have not been included in the original seven firms. These cases are discussed to illustrate their repective roles within Nokia. All have links to Nokia's networks industry in the region and have strongly influenced the development of that industry since the 1970s.

Lauri Kuokkanen[20], the man behind several start-ups

Although the industrial evolution in certain regions is a result of several actions, successes and failures, the role of one leading entrepreneur can be crucial. The Helsinki Polytechnic graduate, Lauri Kuokkanen, who while working for Nokia Electronics in Helsinki during the 1960s, was involved in the development of radiotelephones. After establishing the Nokia Electronics activities in Oulu, Kuokkanen left Nokia in 1976, and established the firm, Insele Oy, to make electro mechanical components for which there was a growing need in the electronics industry. Two years later, Kuokkanen moved on and established a second firm firm, Lauri Kuokkanen Oy, to develop

[20] Lauri Kuokkanen graduated in Helsinki Polytechnic in 1969 in radiotechnology, and worked since then as the Head of the radiotelephone department in Nokia Electronics in Helsinki. He brought that department to Oulu in 1973 and left Nokia in 1976 (Tekniikka & Talous 30.11.2000)

and produce duplex filters for the growing mobile phones industry. After a short development stage and to meet rising demand, this firm started to expand in Kempele, a municipality 10kms south of Oulu. When NMT technology emerged in the Nordic Countries, Lauri Kuokkanen Oy held a strong position in that market. For Nokia, Lauri Kuokkanen Oy became such an important supplier of strategic components that Nokia eventually bought out the firm in 1985 to gain exclusive control of its products, thereby effecting a strategic acquisition from Nokia's point of view (Oksman, 2002). The firm`s name was changed to LK-Products in 1986. In the mid 1990s, LK- Products employed more than 1,000 people in Kempele. In 1998, Nokia sold this firm to a British firm, Filtronic[21] plc.

After selling his previous firm in 1985, Lauri Kuokkanen established a third firm, Solitra Oy, in 1986 to develop and produce radio receivers and transmitters for telemetric usage, later this firm also produced filters for mobile phones. Seven years later Solitra was sold to Rautaruukki before being bought in a management buy out (MBO) and then sold on to the American company, ADC, in 1996. Today (2003) the firm is known as Remec Finland Oy and in 2003 employed about 400 people.

When selling Solitra in 1986, Lauri Kuokkanen retained the department of radio modems and established a fourth firm, Ultracom Oy, to develop data transmission radio devices and Ultraprint Oy to produce printed circuits. In 2000, Ultraprint Oy was sold to JMC Tools Oy. Kuokkanen then established a fifth firm, Ultracrea Oy, to develop radio antennae.

With the exception of Nokia in Oulu, the entrepreneurial actions of one man created more than 1500 new industrial jobs and, in selling those firms, created wealth, which facilitated further entrepreneurial action to continue the process. Furthermore, as a result of this activity, two international firms, Filtronic and Remec, now have plants in the Oulu Region.

In an interview in 2000 (Tekniikka & Talous, 2000), the charismatic Kuokkanen presented his basic principles in business. They are as follows: the products of any firm must have an immediate demand. If the pricing is correct, profits are created and further financial investment becomes realistic. He is against investing heavily in R&D unless income and profits warrant it. Otherwise R&D risks should be left to the larger firms such as Nokia and Kajaani Oy who can afford it.

[21] Filtronic LK Oy produces terminal antennae and terminal filters for mobile phones and base stations. 2/3 of the volume is manufactured in Kempele and 1/3 in China (Kaleva 14.8. 2003, Home page of Filtronic LK OY, read on 1.10 2003)

"It is necessary to make the things, for which there are orders. After that it is a question of how to get those things made. Then the issues of quality and technological competitiveness have to be managed. It is that simple". (Kuokkanen, 2000).

Lauri Kuokkanen claims to be more interested in development work, rather than the management of big organizations. According to him, when an organization begins to grow, other professionals with better know-how are needed. This fits in with phases 1 and 2 in Greiner's growth model, when the basic concept and direction for growth are created. Quite often Kuokkanen left his firms in phase 3, defined as growth through delegation. Kuokkanen is critical of the links between small firms and the university in that there is a possible mismatch between their respective aims and objectives. To survive, firms need a fast rate of return on development, whereas the university´s aims are often more long term. The accuracy of this view though remains debateable.

"I personally have not had any sweet relations with the University of Oulu. I don't want to understate the research done there, but from a business point of view, its operations have been too sluggish" (Kuokkanen, 2000)

In sum, Kuokkanen is an outstanding example of an entrepreneur who has kept abreast of and anticipated change in his industry and has not been averse to taking risks in his business activities.

Scanfil Oy[22], from Subcontractor to Manufacturing Partner

Scanfil Oy is a good example of a firm, which changed from a subcontractor into a manufacturing partner, and responded to the kind of challenges such change involves. Scanfil Oy was established in 1976 by Jorma Takanen in Sievi, 200 kilometres south of Oulu province, before opening a plant in Oulu in 1990. Scanfil Oy was one of the early starters in subcontracting in electrical and mechanical engineering. In 1977 Scanfil Oy started as a component subcontractor to Kajaani Electronics and with Nokia later in the 1980s. Nokia Networks became an important client for Scanfil Oy to the extent that in 2002 the share of Nokia Networks in the turnover of Scanfil Oy was two-thirds its total turnover. Therefore, Scanfil Oy has been very dependent on Nokia Networks. Scanfil Oy describes its changing position as a subcontractor in the following way:

[22] This example is based on the interview of the Managing Director Jorma Takanen in Talouselämä, no 20, 24.5.2002 and the presentation given by Jorma Takanen 21.5. 2002.

- 1980 Supplier (annual contracts)
- 1985 Key Supplier
- 1990 Partnering
- 1995 System Supplier
- 2000 Manufacturing Partner

Source: Takanen, 2002

The steps in this development reflect an increase in the integration between supplier and client over time. The demands for the supplier in each of those steps are (Takanen, 2002) as follows:

- Key Supplier requires know-how of the core business area, speed and quality
- Partnership: reliability, agility, participation in the planning of productivity
- System Supplier: creates a locomotive firm for production network, manages a networked value chain, participates in the planning of products and production systems, operates beside the production of the principal (client), has export deliveries and carries extensive responsibilities
- Manufacturing Partner: global operations and responsibility (in all of the main markets), co-operation in the planning of products and production systems, operates beside the production of client and OEM[23] production.

Scanfil´s overall profile indicates that it has acquired the status of a first tier[24] supplier to Nokia and to several other firms both in Oulu and elsewhere in Finland. This reflects a deepening integration with the principals, but Nokia remains Scanfil's most important client. The relationship with Nokia really took off in 2000 when Nokia expanded its telecommunications operations and more or less took Scanfil with it. With the strengthening of this relationship, Scanfil expanded and in 2000, its growth rate in its financial turnover was 76 %, and the number of jobs rose by 39 %, as illustrated in Table 6.6.

[23] OEM, Original Equipment Manufacture
[24] First tier supplier is analogous with the first class supplier (or "key vendors"/see Lehtinen 2001).

Table 6.6 The development of Scanfil Oy during 1995 – 2001.

	1995	1997	1998	1999	2000	2001
Turnover (M€s)	18,5	75	90	105	180	221
Number of jobs		574	732	758	1050	1250
Growth (%)			28	4	39	19

*Sources:*Takanen, 2002; Talouselämä, 2002

As discussed, Nokia is Scanfil´s principal client, their relationship is one of equals in that, given Scanfil`s expertise and facilities, Nokia has delegated design, development and manufacturing responsibilities to Scanfil so that the latter has in effect become a modular supplier akin to many firms in the automotive industry.

In 2002 Scanfil and another early starter, Wecan Electronics, merged in an attempt to gain scale economies. At the time of the merger, Wecan Electronics employed 550 people and Scanfil more than 1200. The new firm has adopted the name, Scanfil Oy, and is listed on the Helsinki stock exchange. The biggest shareholder in the firm is still the Takanen family. Progress in the 1990s was swift, and strongly cocentrated in Sievi and Oulu, although additionally a plant was opened in Estonia to supply the nearby Baltic market and also take advantage of lower labour costs. Scanfil`s aim is to become a global firm in its own right which explains why it is currently cooperating with Alcatel in France and has recently purchased an Alcatel plant in Belgium to expand its European operations (Takanen, 2002).

Nokia`s Changing Approach to Subcontracting

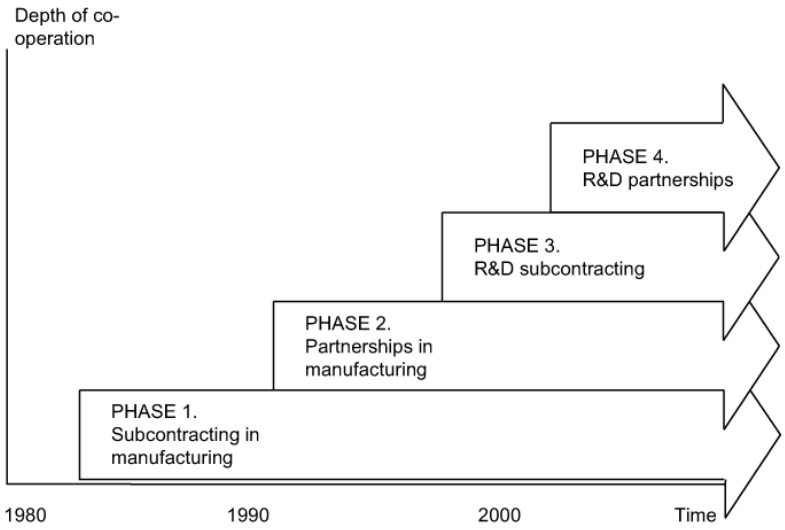
Nokia's networks strategy is analysed by Ali-Yrkkö (2001). Ali-Yrkkö points to the changes in Nokia network's organisational management during the last two decades. In the 1980s, Nokia used subcontractors mainly as buffers to stabilise its manufacturing capacity. The number of subcontractors varied depending on the business cycles. Inter-firm links were weak, and kept at arms' length without any systematic scope for any type of strategic cooperation.

In the 1990s, the situation changed. When the volumes of telecommunication products began to rise, the role of subcontracting was viewed differently; instead of being a buffer outsourcing was recognised as an alternative to internal manufacturing (Vilmi, 2002; Kuivalainen, 2003). The challenge in the 1990s was to manage the fast growth, particularly in the manufacture of base

stations in Oulu. Instead of competitive price tendering, subcontracting became a more systematic way of increasing the manufacturing capacity. In the latter part of 1990, Nokia started to use more component providers and manufacturers, and decrease the number of direct suppliers by delegating more responsibility to system suppliers, as was happening in other industries at the time such as car manufacturing. These system suppliers, especially those with design and R&D capacities, managed the sub- system suppliers and so forth across the supply chain. The links between system suppliers and Nokia strengthened, becoming more like a strategic partnership sharing strategic goals and development risks, and also sharing the rewards from R&D co-operation.

Figure 6.2 demonstrates the development of Nokia's co-operation with its suppliers.

Figure 6.2 The development of Nokia´s co-operation with its suppliers



Source: Ali-Yrkkö, 2001

As discussed above, Scanfil Oy is a good example of deepening co-operation with Nokia. The development stages of Scanfil Oy are similar to those presented in Figure 6.2. Scanfil Oy can be placed in Phase 2 as a Manufacturing Partner. Other suppliers (Filtronic, Remec and SCI Sanmina) occupy similar positions, but are units of overseas' firms.

Co- operation in research and development begins: Elektrobit Oy[25]

Structural changes in Nokia`s telecommunications industry in the Oulu Region can be seen in the role of subcontracting in electro mechanics and the building of partnerships in base station manufacturing. The share of jobs in manufacturing inside Nokia began to fall at the end of the 1990s, but the number of jobs in R&D of base stations actually increased from 350 people in 1997 to over 800 in 2000. Finally, at the end of the 1990s, Nokia established two small R&D units, one in Raahe and another in Kemi which was sold later to Elektrobit Oy.

The co-operation in R&D started later than in the manufacturing. At the end of the 1990s, when the demand for base stations was at its highest, increasingly the R&D in this area was taken up by subcontracting work to outside providers. In 1999-2000 the volume of such work subcontracted was equal to approximately 400 – 500 working years (Vilmi, 2002; Kuivalainen, 2003). Elektrobit Oy became a significant partner in this area of R&D. Much of this type of work such as the design and maintenance of the DX200 exchange system is no longer considered directly as the core business and has increased the willingness to outsource. For example, in 2001, some of the software development, testing and maintenance responsibilities were outsourced to TietoEnator Oy, a Finnish software firm. In the Oulu Region, 60 Nokia employees were transferred to TietoEnator.

One and perhaps the most important partner for Nokia in R&D in the Oulu Region is the firm Elektrobit Oy. Juha Hulkko, graduated from the University of Oulu and founded Elektrobit Oy in Oulu in 1985. Initially, Elektrobit Oy operated in software engineering, but later became involved in Radio Frequency (RF) communications, cellular communications technology and more recently, spread spectrum technology. For Elektrobit Oy, Nokia has been a very remarkable collaborator (Oksman, 2002; Vilmi, 2002).

Co-operation with Nokia increased in the late 1980s, when the development of GSM technology started. Elektrobit Oy has been actively working in this area through, for example, joint research projects[26] based at the University of Oulu where the work was shared between Nokia and Elektrobit Oy (Oksman 2002).

[25] This example is based on the Case of Elektrobit Oy, written by Matilainen, Mattila and Ahokangas 1999 in the University of Oulu

[26] Such projects have been about research on spread spectrum technology and the building of a telecommunications simulator to simulate a telecommunications network (Oksman 2002).

Elektrobit Oy's core business areas (in 1999) were research in telecommunication systems and products, embedded communications and it had two regional based facilities in Tampere and Kajaani in addition to its premises in Technopolis. By 2000, Elektrobit Oy had grown to 100 employees in the Oulu Region and had begun to build an international network with subsidiaries in Switzerland, Japan, the UK and the USA. The reason for building this network was to build up an ability to exploit markets beyond the restricting confines of Scandinavia and to get closer to markets. This type of business model is partly similar to the model of Scanfil Oy, but focused more on R&D.

In 2001 Elektrobit Oy expanded its activities by buying the majority of the shares in Jot Automation, a firm, which had been developed to deliver production automation systems for the telecommunications industry. Jot Automation was one of the "*local stars*" in the 1990s, listed on the Helsinki Stock Exchange, growing and internationalising very fast but, having expanded too quickly, fell into difficulties when market growth stopped. Finally, In 2002 Elektrobit Oy and Jot Automation merged, and the ensuing new entity, Elektrobit Oy, was listed on the Helsinki Stock Exchange. Elecktrobit can be said to represent an example of a successful firm that was brought within Nokia´s ambit because of its R&D capabilities, one which cooperated in joint research projects with Oulu University and one which was able to expand its sphere of operations through acquisition.

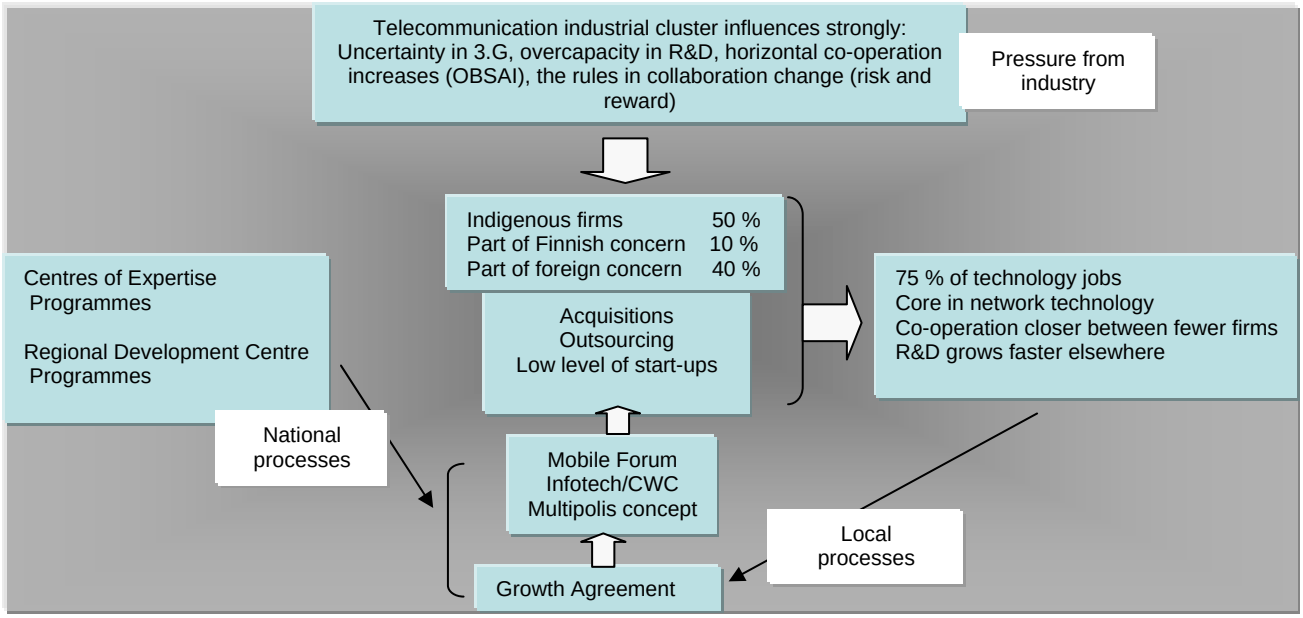
Consortia Cooperation

As the telecommunications industry globalises, firms such as Nokia and others have realised that international cooperation is essential if they are to remain competitive, and so firms across the globe have joined forces to both cooperate and compete otherwise they could find themselves too small to compete individually even within their own countries or regions. This has led specifically to cooperation in agreed standards for base stations. For instance, in research and development, the leading base station manufacturers, Nokia, LG Electronics and Samsung among others, have started horizontal co-operation, where the aim is to agree open specifications for certain parts of the base stations' internal architecture and key interfaces. A new organization has been established for this co-operation, OBSAI (Open Space Station Architecture Initiative). It is defined as follows: "*The Open Base Station Architecture Initiative (OBSAI) is a new organization formed among leading base station vendors, module and component manufacturers to create a set of open specifications for base station architecture. By defining a basic modular architecture and the detailed*

specifications for the internal interfaces between modules, OBSAI aims to create an open market for cellular base stations" and at the same time aims to strengthen the market competitveness (WWW page of OBSAI, read 6th November, 2003).

This all brings new challenges for the leading assemblers and also for their main partners both in manufacturing and in research and development. Growth though partnership with one client is no longer possible. Instead the suppliers have to be able to deliver modules or components to several and develop regional variants of these.The members of OBSAI can be divided into two groups, leading firms and supporting firms, with the former playing the leading roles with help from the latter firms in key areas. The leading firms are (November 2003): Hyundai, LG Electronics, Nokia, Samsung and ZTE (a Chinese company). Of the 38 supporter companies, the following companies are from the Oulu Region (or have units there): Elektrobit, Filtronic, PIC Engineering Oyj, Remec and Sanmina SCI. This example demonstrates that while forums, like the Mobile Forum, can lead regional initiatives, there are other forums (like the OBSAI), where the next international industrial rules will be created. A region's ability to be involved in these processes is in the hands of its firms and their capacity to participate in the leading edge developments (Kuivalainen, 2003). For the firms, and the Oulu Region, this represents the next development stage. For system suppliers, this means deepening their understanding of information and communication technologies. All in all it needs to be emphasised that all the Finnish supporter firms involved in OBSAI have a long experience in the business and strong links with Nokia. As a result, members of the Mobile Forum Group involved in these developments in the Oulu Region have been forced to cooperate and network with each other as a body as well as participating in the Centre of Expertise and Regional Development Centre Programmes, (shown in Figure 6.3), as do the assemblers on a global level. These experiences force firms to learn the success factors in their industry and to anticipate future development demands

Figure 6.3 The telecommunications group in 2002 (n= 10).



Source: Author´s own diagram

X-net Oy, (Nethawk): an example of a company foundation based on Nokia relations[27]

In the 1970s and 1980s, the firms established by Lauri Kuokkanen can be seen as good (and perhaps the only) examples of spin outs of Nokia. Although they are not direct spin outs in the classic sense, the basic knowledge was created in the Nokia environment. Another type of a firm based on the knowledge created in Nokia, is the firm X-Net Oy (later becoming NetHawk Oy), established in 1991. The founding team were all Oulu citizens and graduates of the university, all had worked for Nokia which became ironically their first client. The first business of X-Net Oy was in software development, subcontracted to it by Nokia, while at the same time developing their own product, a protocol analyser for GSM networks, a device designed to analyse the functioning of GSM telecommunication networks. The clients for these analysers are the manufacturers of GSM networks such as Ericsson, Lucent and Siemens as well as operators such as Vodaphone who use these networks. X-Net Oy had an annual growth rate of about 40 % during the 1990s when it built up its own subsidiary overseas networks for its main markets in Hong Kong, Sweden, the USA and France. Despite being a late starter in GSM technology, X-Net Oy grew to a size of 200

[27] This example is based on the case written by Ahokangas and Pihkala 2002.

employees with a turnover of 17 million €uro in the year 2000 through market success and the purchase of another firm, KaskiTech, to increase its capacity and gain acess to Kaski Tech`s R&D.

The mobile phone industry in the Oulu Region

As has been emphasised repeatedly, the dominant industry in the Oulu Region in recent years has been the telecommunications networks-related industries (i.e. transmission systems, base stations, analysers for networks, etc). Activity related to Nokia´s mobile phones and their ongoing development in the Oulu Region, has been increasing since it was decided to return certain design and development activites to Oulu in 1986. Locally, Nokia Mobile Phones has specialised in software development, integrated circuits and digital signal processing. The term which best describes the role of Nokia in Oulu is a `product creation centre`. The reason for establishing R&D in mobile phones in Oulu was the existence of local special knowledge and expertise in digital signal processing in VTT's laboratory in electronics in Oulu (Vilmi, 2002; Väänänen, 2002).

Table 6.7 demonstrates the number of jobs in Nokia Mobile Phones in the Oulu Region between 1990 – 2002.

Table 6.7 The number[28] of jobs in Nokia Mobile Phones in Oulu

1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
40	56	80	110	150	215	300	498	557	570	685	1008	1360	1500	1600

Source: Nokia, 2002

Employment in Nokia's network industry continued to grow in Oulu until 2000 even though R&D activities continue to expand. Employment has now stabilised with a total workforce of around 1,600 opeatives (Vilmi, 2002; Väänänen 2002).

Microcell Oy

From what has been said, the impression may be gained that Nokia is the only firm involved in cellular phone activity in Oulu. This is not the case. In 1997 a small but capable competitor appeared on the scene. Microcell was established by Teijo Postila and several others, all of whom

[28] The numbers between 1990 -1994 are estimates, made together with Nokia people

were at one time or other employed by Nokia. Microcell Oy represents a new concept in the mobile phone business. The business concept of Microcell Oy was to become an Original Design Manufacturer (ODM) in mobile phones and in mobile devices. The firm's clients in 2003 are primarily the manufacturers of mobile phones, who in the face of high levels of competition, have moderated their own R&D resources. The concept of Microcell Oy looks similar to Nokia's product creation centre (which is an in-house centre). Microcell has expanded overseas and has bought production capacity for mobile phones in China from Ericsson. The latter`s R&D unit in Oulu (25-30 people) was incorporated into Microcell Oy in Oulu in November 2002. In comparison with Nokia, however, Microcell Oy is small and has only 200 employees (Kaleva, 2002). So far, it has proved difficult to obtain further details of Microcell Oy`s business relations except that it says that its clients are strong brands in the mobile phone industry and they do R&D work with Sony, Ericsson and Siemens. The firm admits that it plans further overseas expansion, but that Oulu will remain the central point for its R&D activities (Torstensson, 2002). Despite these intentions, in 2003 Microcell Oy was taken over by the Singapore based group, Flexitronics, in an attempt to strengthen the latter`s competences in Original Design Manufacturing (ODM) by adding Microcell`s GSM/GPRS and EDGE expertise to its own.

Industry and University Cooperation

Standardization is playing a crucial role in the development of the telecommunications industry. The success of the Oulu Region in high technology industries is very much a result of Nokia's influence and its success in the GSM standardization process. When the first standards for cellular networks were created, standards were predominantly the rules of the teleoperators. The early market for cellular phones was fragmented and so the technologies varied. The first European standard for digital cellular technology was the GSM set in 1987, which was intended to bring about a degree of commonality for the next generation in cellular technology. Nokia was strongly involved in this standardisation process and exerted a considerable influence in defining standards while at the same time improving the quality of the technology which in itself proved a steep learning curve for Nokia (Vilmi, 2002).

The growth of Nokia into one of the leading firms in telecommunications occurred through GSM technology, and the Oulu Region became an essential part of that growth both in Finland and globally. Research and education in telecommunications in Oulu University has enjoyed a long history of such research and so became heavily involved in the research in this area and played its

part alongside Nokia when the next set of European standards for GSM technology were upgraded in 1998 and based on the use of wideband spread sprectrum technology (WCDMA) (Oksman, 2002).

In the University of Oulu, research into spread spectrum technology started in 1986. This technology was developed initially during World War II and was used in military applications. Oulu University`s first research contract in this field was with the Finnish Air Forces in 1986 and it quickly developed the equipment needed for that research. In turn the university strengthened its postgraduate research in this direction. As a result of this, it was discovered that this technology could also be useful for civilian purposes and in 1987 the university started a research project with Nokia which evolved into ongoing co-operation with Nokia and later with Elektrobit Oy which also participated.

A positive result of the deepening co-operation between the firms and the university can be seen in the strengthening of future oriented research in spread spectrum technology. When the telecommunications industry began to grow in the 1990s, there was an increasing need for trained engineers in this field and the university increased the number of students in telecommunications. Although the regional competition for manpower resources was the biggest obstacle to expansion, the industry and the university ensured that the future oriented research was not put at risk. In close co-operation with each other, the Centre for Wireless Communication (CWC) was established in the laboratory of telecommunications in the University. This is, in fact, an example of a continuation of the first regional strategy as set out in 1992. The CWC operated mainly with external funding and by entrepreneurial recruitment of top-level researchers. In time, local industry and the university built up a clear expertise in a very difficult, but expanding technology:

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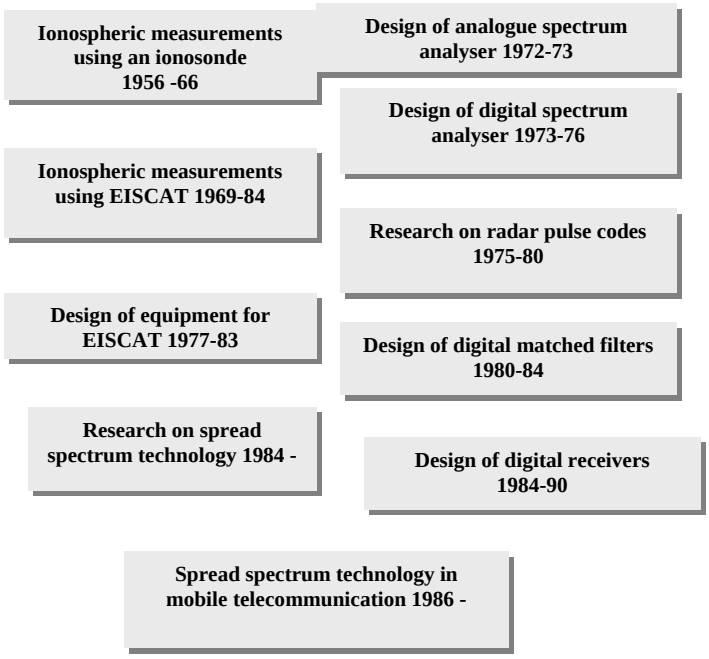
”*In this (spread spectrum) technology Oulu is now especially strong. It was for a long time the only place in the whole country where research in spread spectrum technology was done, now it has spread also elsewhere. This is one reason why Nokia’s research and development in Oulu has increased powerfully. This technology has not yet shown its real value for the success of Nokia, because those are future systems, but I believe in Nokia’s success also in the future. It is not widely recognised that we have a weapon like this in our back pocket*” (Oksman, 2002)

As the above quotation indicates, Oulu has become a clear example of a place where university research and needs of industry have become interwined with each other in a complemenary fashion

to meet the requirements of the telecommunications industry. Figure 6.4 presents the evolution of the research done by the telecommunications laboratory of the University of Oulu, dating back to Oksman`s period of tenure there, as head of department, and shows that it took several decades to build up the relevant levels of expertise:

Figure 6.4 Lines of research of the telecommunications laboratory[29] of the University of Oulu



Source: Oksman 2002

In the 1980s, when the research in spread spectrum technology started, there appeared to be little immediate need for it in industry, only an idea that it could be useful in telecommunications in the future. However, concurrent research work in ionosphere measurement and digital signal processing gave an added impetus to the speeding up of understanding of the potentialities of spectrum technologies. As progress was made, the first real regional benefits became visible late in the 1980s, when digital signal processing became one of the key issues in the development of digital cellular system (GSM, TDMA) and later the need of experts in this area started to grow in the 1990s.

After the fast initial growth stage in the late 1990s, followed by Nokia's success in this technology, new standards were changing the rules in the industry: competition was global, there were no clear

[29] EISCAT is an acronym of European Incoherent SCATter. The Association operates two powerful radar systems (using 224 MHz and 933 MHz); the transmitting site is in Tromsø (Norway) and the scattered signals are received at Tromsø and at additional receiving sites at Sodankylä (Finland) and Kiruna (Sweden). The Association's Headquarters are also in Kiruna (www.eiscat.com, read 7.7. 2003).

global standards, and the future was very unclear. From a research point of view, Oulu firms, Nokia, Elektrobit and even the relative newcomer, Microcell Oy, and the University of Oulu were well placed to take advantage of potential new opportunities if only because of the high levels of expertise and experience that had been gained over time.

A further indication of Oulu`s strength in this area has been its ability to attract overseas partners and external funding for the CWC`s role as an R&D centre. This became increasingly important when mobile phone manufacturing decreased in the area with a consequent growing concentration in design and development work, especially at Nokia. When the CWC was first formed in 1995, funding in came through the Centre of Expertise Programme. In 2003 there were 84 researchers employed and the annual budget stood at roughly 5 million euro. The work inside the Centre was carried out jointly and funded by TEKES, Nokia, Elektrobit, the American firm Texas Instruments and, of course, the Finnish Defence Forces. Current research is focused on the next generation in mobile telecommunications technology (4G) and the expected development time span is 5-15 years (Opperman, 2003). Analysing the position of CWC, Professor Opperman, the Director of CWC, says: *" I think, we will survive the competition very well. We have the links with the firms. We are one of those research organisations globally operating very closely with industry. We belong to the top group globally but are aiming to leave the others behind"* (Opperman, 2003).

6.2.2 Software Engineering

Table 6.8 indicates that five of Oulu`s key firms in the software industry were formed before 1992 These firms are not linked to the earlier described telecommunications firms, though the distinctions between software and telecommunications are becoming increasingly blurred because cellular systems are becoming more and more digital and, in the future, mobile phones and personal computers will probably come even closer.

Table 6.8 The Sample of Software firms

The Firm	Established
CIM Technologies (CIM Tech 1991- CIM Tecnologies 1999 -)	1991
Sypress/Atex Media Solutions	1990
CCC, 3c Software Professional Oy	1985
Elbit	1982
Actasystems (Yomi Solutions oy)	1982

Job creation and growth in this area is illustrated in Table 6.9.

Table 6.9 The development of software group between 1993 – 2001

	1993	1994	1995	1996	1997	1998	1999	2000	2001
Total number of jobs	143	164	180	193	248	283	391	473	495
Growth rate (%)		14.7	9.8	7.2	28.5	14.1	38.2	21.0	4.7
Mean size	29	33	36	29	50	57	78	95	99
Median size	25	28	30	30	34	36	40	45	47
Mean deviation	18	21	22	25	32	37	69	90	92

Source: OBR

From this it is clear that it was not until after the mid 1990s that significant expansion occurred which was in line with the growth and development of the firms concerned. These firms were all established by local entrepreneurs, at least three of whom were Oulu University graduates and this sample represents roughly 40 % of the jobs in the software industry in the Oulu Region.

As a job provider in the Oulu Region, the role of the software industry does not seem to be as crucial as telecommunications, but in accord with the increasing emphasis on this sector its relative importance to Oulu's economic vitality has been growing in recent years. According to the official statistics, the number of firms (units) in software and computer services in the Oulu Region has grown from 59 (in 1990) to 117 (in 1995) and to148 (in 2001). The number of jobs has grown from 396 (in 1990), 421 (in 1995) to 1,454 (in 2001). Similarly, the data shows that software related services have grown particularly between 1995 -2001.The number of firms has grown by 26 % and the number of jobs by more than 200% in these six years. Initially, the average size of a firm was very small, requiring little start-up capital and employing only 3-6 people on average, although this has since grown to 10 people (OBR, 2002, Statistics Finland, 1995-2001).

6.2.3 Electronics

There are five firms included in this group, all of whom have been engaged in product development. Noptel, for instance, specialises in laser devices for guns and rifles, whereas Tracker, as its name suggests, makes tracking devices. Table 6.10 presents the age profile of a sample of these firms and indicates that they have a long history in Oulu going back as far as the late 1970s and were locally founded by local entrepreneurs, as in so many other cases in Oulu`s industrial history, being local university graduates. Table 6.11 demonstrates the development in terms of jobs in the Oulu Region, which rose from 146 in 1993 to more than 400 in 2001. Furthermore, the median size of firm has increased from 29 employees in 1993, to 47 over the same period.

Table 6.10 A Sample of Firms in Electronics.

Noptel Oy	1982
Polar Electro oy	1977
Jutel Oy	1984
Buscom Oy	1986
Tracker Oy	1978

Table 6.11 The Growth in Jobs in the Electronics Group in 1993 – 2001.

Electronics	1993	1994	1995	1996	1997	1998	1999	2000	2001
Total	146	164	177	196	233	281	306	387	410
Growth rate		12,3	7,9	10,7	18,9	20,6	8,9	26,5	5,9
Mean size	29	37	40	49	54	66	77	97	102
Median size	24	28	28	31	34	39	39	45	47
Mean deviation	21	24	28	38	41	52	68	91	99

Source: OBR

The background of these firms demonstrates extensive technological development in the Oulu Region. Two have roots in Kajaani, Kajaani Electronics, Jutel and Buscom, whose early development was funded by Kajaani Oy prior to being sold off in the mid 1980s. The situation in 2002 of the firms in this sample, represent more than 90 % of the jobs in the region in electronics firms with their own products (OBR, 2003).

Two of these firms in particular have strong links with the university (i.e. Polar Electro and Noptel). Noptel cooperates in applied research in optoelectronics done by the University of Oulu, and Polar Electro was established by Seppo Säynäjäkangas, a former Professor of Electronics in Oulu University. The outstanding firm in this group is Polar which is described in the next section below as an illustrative example.

Polar Electro Oy

Polar Electro Oy[30] was established in 1977 by Seppo Säynäjäkangas who, as mentioned above, was a professor of electronics at Oulu University in the 1970s. His speciality lay in the development of heart rate monitors that could be used to measure the heart rate performance of athletes, and has since been extended to monitor patients with cardiac problems. While working at the university, he set up his own business close to Oulu airport, and this has grown successfully into a world leader in this type of technology with its products being sold extensively in America and the UK. Polar`s links with the local economy are extensive. It currently leads a consortium of 44 concerns in the Northern Ostrobothnian Wellness Programme in the public policy area, drawing on areas such as biotechnology, telecommunications and wireless technologies in partnership with both the university and the polytechnic, and Oulu University Hospital where the programme is based in the Centre for Telecommunications Health Care. The success of this programme has been very highly dependent on the levels of cooperation and networking between the respective parties as they have brought their skills to bear on a vast project, covering virtually the entire north of Finland (Technopolis, 2002).

Although the R&D continues to be carried out in Oulu, production has been outsourced to a plant in Hong Kong which was acquired initially in the 1980s. At the time of writing, 90% of all Polar products are made in Hong Kong and there are firm plans to open factories in China and Malaysia with their low labour costs. As Jorma Kallio, the firm`s present managing director says: "*There is no hope of being competitive within the current level of costs in Finland*" (Talouselämä 17.4.2003). Overall, Polar Electro Oy has operations in more than 40 countries; its exports are about 95 % of its turnover, but it is facing strong competition in a mature market from larger and more powerful brands in the same field such as Casio, Seiko, Swatch and Timex. Nevertheless, the firm has built up its own industrial group, even if this is in a niche market, by acquiring two other Oulu firms,

[30] This example is based on the case, written in March 1997 by Marttila at the University of Oulu (November 2000) and an article on Talouselämä (17.4.2003)

Idesco Oy and Buscom Oy. Finally, it is illustrative of a university spin-off, the development of a specialist market and also of a small firm making its mark in the global economy (Marttila, 2000)

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6.2.4 The role of biotechnology and Medipolis

The pharmaceutical industry has a mature history in the Oulu Region. Since the 1960s, there has been pharmaceutical production in the area employing a few hundred employees at Medipolar Oy, which later became part of the Finnish pharmaceutical firm, Orion. In the 1990s, the pharmaceutical industry began to rationalise and the entire production in Oulu was transferred to Turku, which is one of the industry's leading centres in Finland. The first indigenous firm based on research done by the Oulu University was Nordiclab established in the late 1970s in Oulunsalo, close to the airport. The business idea of Nordiclab was based (and still is) on diagnostics. Nordiclab was later sold to the abovementioned pharmaceutical firm, Orion, when its name changed to Orion Diagnostica but the activities - mainly research and development work - stayed and strengthened in the Oulu Region (based on the author's own observation while working for the Ministry of Trade and Industry, 1976-89).

Biotechnology research has been strong in the University of Oulu, in the Biocenter[31], which represents an umbrella organisation for all biotechnological research in the institution. In total there are more than one hundred researchers working in different project groups. In the late 1980s, bio and medical technologies were seen in Oulu as potential growth areas by the City Council to complement the university's teaching hospital and medical school. To encourage the biotechnology industry to grow in the region, Medipolis, a spin-off from Technopolis, was set up very close to both institutions in 1991. The main idea for Medipolis was, similar to that of Technopolis, high standard premises, proximity to academic research, the hospital and education institutes and to act as catalyst for new industry. Medipolis`s role was to provide environmental friendly incubating units (including also laboratory facilities) for small, newly started firms wishing to embark on the type of research which could be availed of through the expertise from both the hospital and the university's academic departments. Indeed, this has happened through staff interchanges with university doctoral and post-doctoral researchers carrying out their work within several of the biotechnology firms (Similä, 2002). In *"The Business Development Strategy of the Oulu Region"* in 1993 biotechnology and medical technologies were selected as key technologies. A more focussed strategy for the biotechnology and medical technologies was created in 1996 led by managing

[31] Biocenter has been a research unit by the Centre of Excellence status since 1995 (the Finnish Academy)

director of Medipolis. The strategy was very growth-oriented, aiming to quadruple the number of jobs (from 700[32] to roughly 2800) in these technologies during the following decade (Lampelo, 1996). This strategy included several projects in order to achieve this. One of those was the idea of strengthening Oulu´s and Medipolis`s position as a high-level research and development place in product development by establishing the new GMP[33] factory close to the Medipolis. In that strategy the role and activities of Medipolis were defined. The problems that the new firms in these technologies were facing, were similar to the problems in the early stages of growing firms, the technological know-how was strong, but there were weaknesses in other areas such as early stage financing and marketing (e.g. Greiner, 1972). The new role for Medipolis was identified as being to assist the new firms in networking and joining limited resources in order to achieve better access to finance and opportunities in the market (similar to the early stage of regional clustering described by Pouder and St. John, 1996).

One promising new kind of firm in the middle of the 1990s was FibroGen Europe Ltd (subsidiary of FibroGen Inc). FibroGen Europe Ltd was located in Medipolis and employed a dozen researchers and was strongly linked to the research of biomaterials done in the Biocenter (with e.g. Professors Kivirikko and Pihlajaniemi, among others). The presence of this firm influenced the discussion and planning of the abovementioned GMP factory. In early 2000, this research was relocated to California and the unit in Medipolis was closed down.

However, the overall development in biotechnology processes and product development has not been as dramatic as in ICT technology and has in fact been rather disappointing. This has not only been the experience of Oulu, but also of the whole country, especially as progress in this field requires considerable start up funding and product development, as it is under government regulation, and is therefore slow and risky. In spring 2003, eleven years after the establishment of Medipolis, there were 25 biotechnology firms in the Oulu Region; 10 of which were in diagnostics, 3 in pharmacy, 5 in pharmaceutical services and 7 in biomaterials and functional foods (BioForum, 2003). All of these firms are small, and the OBR database shows the total number of employees is less than one hundred and accounts for only 1% of jobs in the NTBFs (OBR, 2002; Kaleva 4.5.2002). In addition to the biotechnology, there are also firms in well-being industry (e.g. ProWellness Ltd and NewTest Oy) and in medical technology (e.g. Innokas Medical Oy). For these

[32] Polar Electro is included to those numbers
[33] GMP= Good Manufacturing Practise, this was an 11 million Euro investment (Kaleva 25.10.2003)

kinds of firms, the environment offered by Medipolis is favoured by its closeness to research and the university hospital.

In contrast to the financial success of Technopolis, Medipolis failed to yield a profit and in 2002 was forced to merge with Technopolis and come under its direct control. Matters were not allowed to rest and attempts were made to encourage and accelerate the development process of the biotechnology industry and further infrastructural investment was made. In spring 2002, a new company, Medipolis GMP Oy, was started as a subsidiary of Technopolis. The function of this new entity is to speed up the R&D process in biotechnology by offering clean production facilities for the test production of pharmaceutical products but, to date, little progress has been made in this area (Technopolis: Annual Reports, 2002-2003).

While the Oulu Region has become one of the leading technology concentrations in the Nordic countries particularly in telecommunications, electronics and software industries, a good example of another type of development is in Sweden in the Lund area, where the second Nordic technology park was established in 1983 (see page 63). Lund and the surrounding areas (including Malmö) have become the leading Nordic concentrations in biotechnology and pharmaceutical industries.

6.3 Conclusions

Following on from what has been said in this chapter and in the previous one, Nokia's success in the ICT industry has helped to generate a group of firms, whose social, educational and cultural origins were primarily regional and have benefited considerably from Nokia`s expansion in producing base stations and its expertise in ICT since the 1970s. With its subsequent involvement firstly in NMT technology, and later in GSM technology, Nokia learned to anticipate the competencies and resources needed in the new industry. Indeed, the Nokia case is illustrative of the models presented in Figures 2.3 and 2.4 (Sandgerg and Hofer, 1987; Autio, 2000; Amit and Shoemaker, 1993) of how this kind of process is essential to creating an understanding of the industry specific success factors and the role therein of company specific resources and capabilities. Similarly, the growth models in Figure 2.2 and Table 2.2 demonstrate similar situations, although these cannot be linked as strongly linked to the ICT industry. The problem from Nokia's point of view has been (and still is) the fast pace of evolution and the difficulty to keep pace, to which there is little alternative but to attempt to achieve parity through its own agility in its subcontracting and

outsourcing relations with local suppliers and overseas competitors, in what might be termed a communal learning partnership venture.

As job providers, although the role of this regional cluster seems to be decreasing it does not lessen its importance. When looking at the links between the firms and their links to research, it is obvious that, as a result of the enormous regional (and global) growth in this industry, Oulu has established itself as a competitive place for the future and appears to be getting stronger in certain fields. The longterm research - done in the department of electronics in the University of Oulu and VTT and others - in particular creates a strong basis for increasing and maintaining the leading position held by Oulu (see Figure 6.1) and there is little doubt that this healthy interaction has gone a long way to influencing the area`s development and facilitating networking opportunities. A good example of the regional innovative response to a technology based business strategy (originating from the work done in 1992) is the Mobile Forum concept, where the participants of industries, research and educational institutes jointly define the regional strategic development lines, create projects in order to strengthen the co-operation between research and firms, and generate new local initiatives in order to boost the emergence of new business ideas.

The software and electronics groups have followed a different development path. Whereas the average company in the telecommunications group (excluding Nokia) grew sixfold in terms of employment, in the software and electronics groups the firms hardly doubled in size. Those industries have not been so strongly influenced by one emerging new industry (cluster) - such as telecommunications – and show much less dramatic growth. With regard to the growth in employment, particularly in electronics, the growth has been higher abroad (e.g. Polar Electro has 75 % of its jobs abroad) due to the setting up of overseas subsidiaries. In other words, Oulu has developed as a research and development centre rather than one simply providing manufacturing or assembly jobs. This increases the importance of the role played by higher education and similar establishments. From a firm’s point of view, the growth can be seen to be cyclical (as presented by Greiner in 1972, Churchill and Lewis in 1983, Scott and Bruce in 1987, and Kazanjian and Drazin in 1990).

7 Conclusion and Recommendations

7.1 Conclusion

This study shows that the regions of Oulu and Northern Ostrobothnia in Finland have undergone a dramatic economic transition since the 1970s. A number of conclusions can be extracted from the Oulu Phenomenon which show what can be achieved through the combined actions of a number of actors within a specific socio-economic and cultural setting interacting with international and global trends. It is not the intention here simply to repeat a narrative and recapitulate on the basic facts, but rather primarily to pursue a number of themes to elucidate the main points. These are laid out in Table 7.1 and will be followed in sequence rather than in any precise chronology. This will be followed by a discussion of the validity of the work and by recommendations for future research.

Though there are specific features unique to what happened in Oulu, particularly due to its relative geographic isolation, it must be remembered that similar experiences were taking place elsewhere in the global economy. Much of this was predicated on advances made in micro processing technologies which underpinned many of the major technology changes that have occurred in the telecommunications, computer, computer software, electronics and biotechnology industries since the 1970s. Oulu was by no means at the leading edge of microprocessing technology *per se*. Its strength lay in being able to capitalise on it in a commercial sense. Most of the changes that occurred took place either in Oulu itself or within its immediate hinterland, but had a knock-on effect over time spreading to other towns and municipalities, such as Ii, Kempele, Haukipudas, Ylivieska, Raahe, Rovaniemi and Kemi which in turn set up small industrial parks to develop and nurture modern industries. The outcome was that gradually small pockets of newer technologically based firms mushroomed across Northern Finland. Some were more successful than others, but nearly all were in close proximity to either a university or a polytechnic.

Table 7.1 Concluding Themes

THEMES	SUB THEMES
National Initiatives	Government policy
Local Initiatives	Local approaches to government policy
Anchor/Locomotive Firms	The role of Nokia
Emerging Sectors	Telecommunication, software, electronics, biotechnology et.,
Cultural Settings	Socio-economic culture in Northern Finland
Clustering/Networking	Relations between firms and institutions
Internationalisation	The influence of globalisation
Type of Work (R&D v. Manufacturing)	Assembly/manufacturing versus R&D
Limitations	What has been the impact on the Oulu Region.

In any discussion of this nature, it is essential in the first instance to recognise the serious economic limitations which prevailed in Northern Finland in 1950s. Northern Ostrobothnia and Lapland were areas suffering from distinct economic and social deprivation, which manifested themselves in incomes well below the national average, short life expectancy, an extremely poor transport communications system, low educational standards and an increasing incidence of outwards migration of the young and better educated people to the region of the capital, Helsinki, either to find employment or to enter southern based universities and other higher education institutions as there were no alternatives in the north except for what might be loosely called Further Education or Vocational Schools. Such problems were visible in the regional employment structure. While it was relatively easy for men to find work in forestry and agriculture and to a lesser degree in the pulp, paper making and metallurgical sectors, there were few job opportunities for women.

These problems were serious and could not be ignored either by the national government or the regional authorities in the northern cities and muncipalities. It was recognised in the 1950s and 60s that these difficulties would not be overcome unless there was some positive national government intervention through long term investment in the less favoured regions. This type of approach was a common feature in several European economies at this time, most notably in the UK, France and Italy. The Finnish government had little choice but to take action and for this reason, from the mid 1950s onwards, the national government policy became much more positive and proactive.

The northern problems were tackled in a threefold manner. The focus areas were the problems related to educational opportunities, unemployment, and infrastructural deficiencies. The initial approach to education and to a lesser degree unemployment was institutional. The first approach was to set up a teacher training college and then, secondly, a university was established in Oulu in the late1950s. These were highly instrumental in their mission, with a utilitarian philosophy, aims and objectives. In particular, the university was given the responsibility of organising courses and conducting research programmes that were specifically relevant to the economy and infrastructure of the region. It was intended that through its courses the university should provide engineers to facilitate the generation and distribution of electricity in the north through cooperation with the hydroelectric authorities. The earliest faculties established were in the fields of engineering and medicine. Moreover, the university was perceived as a jobs' provider for women. In other words, the university was an investment rather than a cost to the exchequer. Finally, central government initiatives were not confined to simply setting up educational establishments, a great deal of investment was undertaken to improve the infrastructure and the road system to ease travel between north and south and east and west, particularly between Oulu and its eastern counterpart, Kuusamo, near the Russian border.

A second conclusion was that setting up an educational framework was a necessary cause of improvement, but not a guarantee of economic prosperity travelling north. Additionally, Northern Ostrobothnia and the Oulu Region suffer from near Arctic conditions and natural resources are scarce, precarious and require careful husbandry. Thus it was clear that any industrial growth would have to be based on the development of industries not bound by a weak indigenous resource base. In other words, to survive, economic diversification was clearly essential. With hindsight it is doubtful if much would have happened had it not been for the setting up branches of VTT and Tekes in Oulu, again due to government intervention. Both of these institutions were associated with technological development in Finland and, given the emphasis on technology and engineering, Oulu University was at least one obvious location for the activities of both institutions in Northern Ostrobothnia. Therefore, taken together, the tripartite collaboration of the university, VTT and Tekes helped to forge the path for the development of a modern viable industry for the Oulu Region. It could be argued that much of this was predicated on the application of the Growth Pole Theories of the time, but that would be an over-simplification of what actually happened. Nevertheless, the role of the national government cannot be underestimated in its attempts to establish an institutional framework in which the northern Finnish economy might improve its chances of long-term economic growth and development.

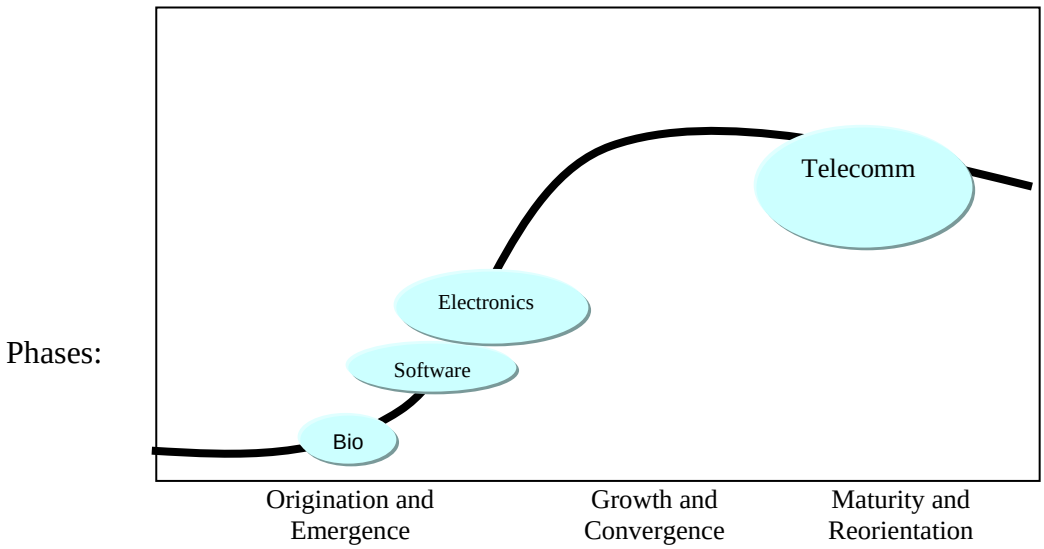
A third factor in the dynamics of the Oulu Phenomenon is the unique role played by the city and municipal councils in partnership with the national government, local institutions and corporate interests. Although broad regional policy devices and instruments were set by government ministeries in Helsinki, policy implementation was highly devolved and decentralised. When the baton was taken up by the local authorities, it was this that effectively moved the whole process towards implementation. For example, regional seminars were held in the 1970s which led to the setting of specific strategic actions, notably by the Oulu City Council in conjunction with the university and a group of entrepreneurs who were already working in the slowly emerging electronics industry in the region. Several revelations proved fortuitous at that stage. Firstly, it was recognised that growth and development would be dependent upon an increased supply of university educated engineers, able to understand and build upon the potential of the emerging microprocessing technologies. It also became clear that if progress were to be made, the ensuing jobs would not be suitable for less educated female labour either in Oulu or Lapland as first thought, and that the role of the Oulu University and of VTT would be paramount in the education process. They also realised that a specific facility was required to gather the resources and serve as a focal point where the firms could work together, cooperate and learn from each other. It was this latter fact more than any other which persuaded Oulu Council to set up Technopolis and locate it as close as possible to the university and VTT so that they could provide academic and technical support to aspiring firms.

Much economic theory in the 1960s and 70s focused on the role of large firms moving into deprived areas where they could act as catalysts and stimulate local firms or attract firms from elsewhere. The firms involved in this process, as discussed before, are often referred to as locomotive or anchor firms. In this context the arrival of Nokia from Helsinki to Oulu is fundamental in the development of the high tech industries in the area. Nokia received no direct government assistance in its move north, but it is perhaps safe to venture that, aside from escaping its labour difficulties in the Helsinki region, it might not have done so if it had not been for the prospect of a lucrative defence contract from the Finnish army, which could be described as an indirect form of public funding. Nokia´s arrival is particularly important in several ways. Firstly, it brought new radio technology to the area. Secondly, it developed into a world leader in telecommunication technology through its base stations and subsequent design and development work in mobile phone technology, specifically in Oulu. Thirdly, it not only provided a significant number of jobs, but was prepared to cooperate with relevant departments and sections of the

university and VTT in an attempt to establish a networking culture. Fourthly, its catalystic impact needs strong emphasis as its subcontracting and outsourcing activites in the region spread its own technical expertise in developing new technologies, and it reciprocally benefitted from the expertise of its working partners, such as Elektrobit. Finally, its success in achieving global status through strategic alliances and overseas partnerships has been an important factor in drawing attention to what has happened and still is happening in Oulu generally, and so enhance the region`s expertise in the fields of digital communications.

While Nokia played the role of anchor firm, another key feature of the Oulu Phenomenon was the interactive role played by small firms and the consequent emergence of a regional cluster of four main sub-groups which as Figure 7.1 shows currently differs in size and maturity stage.

Figure 7.1 The evolution stages of dominant industrial groups in 2003.



In common with NTBFs elsewhere there was a distinct economic, social and cultural focus heavily influenced by institutional features. A considerable number of the entrepreneur-founders of firms came from the region, were of the same religion, had attended the same type of secondary schools and were graduates of the Schools of Engineering at Oulu University, and to a lesser degree the more recently established Oulu Polytechnic. Hailing from the same roots and often requiring little start up capital, except in the case of biotechnology, it was relatively easy to form a business with

some ten to fifteen years work experience. Moreover, it could be argued that friendships and social contacts over time, combined with the proximity to the university, VTT and Technopolis, might well have been the key factors in building up the cohesive group identity, which was further consolidated by participation in courses, training events and seminars provided by the higher education institutes and Technopolis.

It is within the above context that the role of individuals in the Oulu experience should be seen. Although a great round of applause goes to the the various instituions and groups involved, there is little doubt that much of what happened needs to be accredited to the role of specific key individuals whose drive, experience,willingness to implement policy, innovate and effect change were crucial. Firstly, there is the role of far sighted people such as Oksman, Mannerkoski and Otala at Oulu University who foresaw the possibilities of what a burgeoning electronics and telecommunications industry could achieve in regenerating the Northern Finnish economy. Secondly, tribute needs to be paid to the members of Oulu City Council and its officials, such as Paavo Similä, who grasped the nettle and with the help of others drove the refrom process forward in the face of opposition from those who were more intent on simply trying to breathe new life into older industries. Finally, there were entrepreneurs such as Kuokkanen, Takanen, Hulkko, Oukka and Postila and other key actors such as professor Säynäjäkangas who helped create new firms and so bring original visions into reality. In other words, in concentrating solely on broad economic, political and social forces, the basic human dimension and essential role of individuals (even of those local municipal and industry representatives such as Mining Counsellor, Tähtinen, who merely participated in 1970s regional seminar series) involved in the important restructuring of the Oulu region's economy might well be overlooked.

With regard to internationalisation, as the microprocessing revolution has been global, the Oulu experience has played a part in the global evolution of modern industry, particularly in telcommunication systems. This has meant developing products capable of meeting international standards and working with overseas multinationals such as Samsung and Texas Instruments among others. The value of this is that the very nature of the industries which have evolved in Northern Finland have forced Finnish firms to reach beyond their regional and cultural confines - a process greatly assisted by ICT – and participate in the wider global economy in product development, outsourcing strategic alliances and joint ventures to take advantage of lower labour costs elsewhere. Although there has been little foreign capital invested in Oulu´s new industries, the few overseas firms which have invested in the region - such as Remec, Filtronic and Flextronics - have,

nevertheless, added to job creation in the region and brought their own expertise and multicultural influences to their respective sectors. Finally, an added and important impetus to the growing internationalisation of the region lies in the simple fact that the Finnish and nearby Scandinavian markets were of themselves too small to sustain industrial growth in Finland and there was little alternative, especially after Finland joined the European Union in 1996, but to try to compete in the wider global environment.

The final point in this analysis is to emphasise that, while the government objective of halting an overall population decline has been achieved and Oulu City itself has experienced the inwards migration of young professionals seeking work, the growth in investment and the emergence of newer industrial structures, with the exception of base station production, has failed to create a strong long-term manufacturing base in Northern Finland. The majority of firms are small, especially in the software and biotechnology sectors. Many of the firms concentrate almost entirely on R&D projects and so unemployment has remained a stubborn feature across the region, still running at above the national average. Moreover, with strong growing global competition in the very areas which have been built up in Oulu and Northern Ostrobothnia, Finnish firms may prove vulnerable in the longer term. To survive there may be little choice, but to continuously upgrade their knowledge base and innovate at the forefront of their respective technologies if they are to survive in a highly competitive international environment. Otherwise the Oulu Phenomenon may well prove a chimera.

7.2 The theories and the future prospects

Following the introduction to the features of the Oulu Phenomenon, an extensive literature review was carried out both to contextualise the thesis and to justify the research questions posed and the methods used. Four specific areas of literature were consulted: business cycles and industrial development, company growth models, the evolution of regional clusters and industrial districts/milieus. Each of these made a distinct contribution to the development of the thesis. The study of the business cycles from the work of Schumpeter and Kondratieff through to Marshall facilitated an exploration of the role of technology and the importance of innovative entrepreneurship in capitalist economies over time, which in turn helped explain comparative changes in industrial development. Secondly, beginning with Greiner, it was possible to follow the debate on the growth of firms and identify the various stages in the growth development. The importance of that was to emphasise the role played by those who founded firms. Equally, this

debate opened the way for a discussion of the role of resource based management through the work of Amit and Shoemaker. Finally, a discussion of the work of Porter, Lovio and Pouder, St John grounded the discussion of cluster evolution, and the latter two works explained the dynamics of cluster evolution more than the work of Porter. Finally, the literature review, in addition to opening up the role of anchor firms, was extremely useful in explaining the role of the various networks, of the support institutions and the importance of local culture in sustaining enterprise communities in local areas. It was only by examining a wide range of literature and sources that the thesis actually took shape and pointed the way to appropriate research methods.

Figure 6.3 (page 177) and Figure 7.1 (page 194) demonstrate the situation in the high technology based industries in the Oulu Region in 2002. Figure 7.1 reviews the evolution stages in each of the main technological groups, based on the information presented in Chapter 6. Figure 6.3 presents a more detailed cross-sectional model of the situation in the telecommunication group based on the use of different information sources and theories presented in this study. In the early stages of the Oulu Phenomenon, there was no clear business model dominant, rather the technologies and increasing resources (research and educated people) were the driving forces in realising the early visions. The early stages of company growth theories and regional clustering theories (e.g. Figure 2.5) explain this kind of situation. Some NTBFs could achieve growth (e.g. as Polar Electro did) but the industrial development was also problematic, as the Kajaani Electronics case demonstrates. Since the mid 1980s, Nokia's increasing influence began to change the local industrial environment. Nokia, in Oulu, increased its co-operation with some local firms (such as Scanfil and Elektrobit) and the research institutes could provide an improved understanding of the evolving industry, telecommunication, and catalyse the growth, as demonstrated in Figures 2.3 and 2.4, or elsewhere in cluster evolutions by Pouder and St.John or systemic evolution by Yli-Renko and Autio. The Fast Growth stage in the 1990s included a dramatic increase in the number of jobs in telecommunications while, at the same time structural changes, which polarized the regional industrial structure, as Figure 7.1 demonstrates.

The other industrial groups, electronics, software and biotechnology can be positioned in an earlier stage of regional cluster development (according to Pouder and St.John), when we consider indicators such as the growth rate of jobs, the number of firms, the intensity of co-operation (as reflected in the OBR).

Future prospects

The situation, described above, offers also some possibilities for evaluating the future prospects of the industrial development in the Oulu Region. This is possible to do according to the groups, presented in Figure 7.1.

Telecommunications has developed into the dominant industry, providing ¾ of all high technology jobs in 10 firms or units located in the Oulu Region. As shown in Figures 6.3 and 7.1, this regional group is positioned in the mature and reorientation stage (see also Figure 2.6). The fast growth stage has linked these 10 firms closely together. However, the halted growth brings new challenges. Those firms which have grown with Nokia, or some which have even originated from Nokia, must be able to create new partnerships in order to continue their growth. Nokia is still strongly rooted in the Oulu Region partly due to its long history and stabilized co-operation network here. However, as explained in Chapter 5, the growth has ceased in the Oulu Region at the time of writing. Nokia's partner network in the Oulu Region can be divided into two categories, those foreign-owned companies (such as Flextronics, Remec, Filtronic and SCI Sanmina), and those others predominantly owned by local entrepreneurs (such as Elektrobit, Nethawk and Scanfil) with their headquarters and most of the R&D activities in the Oulu Region. These latter are, as Nokia in Oulu, also rooted to the region, even though the growth takes places elsewhere. As the theory of systemic evolution theory of NTBFs showed (Yli-Renko and Autio 1996), NTBFs can develop their own distinctive competencies with the anchor company and then link into other networks or clusters and become less dependent on the initial cluster. Elektrobit, Nethawk and Scanfil are each behaving in this way, and these kinds of firms could prove to be the future anchor firms. Very important factors for the future development of the region are local ownership, and local loyalty to these firms, even when they have strong links outside the region.

The firms in the electronics group have been following a similar development path as the indigenous firms (such as Elektrobit and Nethawk) in the telecommunication group, but the growth rate has been much slower. The ownership and R&D activities are local; the headquarters are in the region although the growth takes place elsewhere, and these firms are also embedded in the region providing reasonable stable development.

The third group includes firms in software, biotechnology and medical technology. These firms are at an early stage of development and have not benefited from the fast growth stage. For these firms,

the fast growth in telecommunication industry has formed a business model, where local and national markets and demand can act as a catalyst in creating new industry, and further provide a unique business environment. In the development and utilisation of wireless technology, the Oulu Region is one of the world leaders. This business environment can act as a catalyst and "*test laboratory*" to create new, cross technological solutions in areas such as e.g. health care, service industry utilising wireless technology, process control and logistics.

It is clear that the high technology industry is strongly embedded in the Oulu Region, and the situation can be regarded as rather stable for the near future. In order to create new growth, the region is facing a new entrepreneurial era, very similar to the early 1980s. There are options and a unique environment in which to proceed, but there are also new challenges; Oulu is not the only place in this kind of position.

7.3 Reliability and Validity of the Study.

A particular challenge in writing this case study has been to test its validity over time in demonstrating and analysing the events that took place in Northern Finland between 1970 and 2002. As case studies are often unique in themselves, there is always the question of their relatability to experience elsewhere. However, the Oulu-Northern Ostrobothnian experience relates to a number of themes connected to the growth of high tech industries, such as the respective roles of national and local government policy, the role of key institutions - such as universities, specialist laboratories - and specific bodies - such as Technopolis - to support industrial growth and development by supplying financial, academic and practical support services. Similarly, it illustrates the role of anchor firms coming from outside, and discusses the particular regional economic, social, educational and cultural characteristics and origins of the founding fathers of many of the firms involved. Moreover, there has been an attempt to illustrate the various forms of networking that evolve through interaction between the institutions, firms and regional authorities and how concerted actions can facilitate a near industrial revolution in a regional, national and international context even if it is confined to a relatively very small corner of the north-western periphery of Northern Europe.

The study has attempted to achieve a balanced view of events, bodies, processes and the roles of individual people and firms in the process by choosing an appropriate research strategy. This included various methods such as participant observation, in-depth interviewing, survey questionnaires and documentary analyses for collecting the evidence. It was fortunate that there

were a sufficient high quality of sources and materials available for consultation and that many relevant individuals in both the public and private sectors freely gave of their time to be interviewed.

The evidence in the public domain from the regional and national authorities proved to be of varying quality, mainly due to the lack of disaggregated regional data, but they were made freely available. An invaluable source of information has been the *Oulu Business Review*. The value of this is that its surveys have been an ongoing accumulation of vital information collected on the local economy for more than a decade and has an extremely high rate of return on its survey questionnaires. It can be safely concluded that the data published in the OBR is a reliable source for this type of business analysis and helps to compensate for the glaring statistical deficiencies in official Finnish statistics. Finally, the statistical data in the OBR was complemented by qualitative information extracted from the main newspaper of Northern Finland, *Kaleva*, and other regional publications.

It is often easy to criticise the validity and reliability of interviews, especially when conducted with people who were involved in events and processes many years earlier. However, in this instance and following a consistent interview technique, the responses to questions, though often varying in depth, provided sufficient commonality to enable a reasonably accurate picture and interpretation of events to be formed.

There were times when it proved difficult to play the role of a detached observer, especially when the author has been involved in the initiatives and development processes in his work first in the Ministry of Trade and Industry in Oulu, and then subsequently in the University of Oulu. Of course, there was a feeling of personal bias due to experience, but that had to be offset when weighed against other and often better informed opinions of the interviewees. It is to be hoped that such personal prejudices have been minimised in the analysis and interpretation of this thesis.

In the light of the above discussion, it is safe to conclude that the information gathered is valid and reliable, if only because it was possible to cross-check sources and interviews through triangulation and to clarify questions in person with the key actors over time, as well as interviewing them officially.

7.4 Further Research

While a great deal of time and effort has gone into preparing this thesis, it is clear that only part of the explanation of the Oulu Phenomenon has been uncovered and that other topics remain ripe for exploration and analysis. More research is required into the precise role of the university, for example, in encouraging both internal and external entrepreneurship. Perhaps this calls for a more instrumentalist approach to the role and function of higher education institutions in their own specific regions. Should they be instruments of government policy, ivory towers or a combination of both? Similarly, little has yet been examined from a spatial point of view of the distribution of the development across the region to explain why some areas prospered in encouraging new industry, whereas others failed after only a short time. Indeed, the important aspect of the early cooperation between Oulu City, the entrepreneurs and local institutions requires further exploration in a cultural context possibly in terms of a mental model specific to Northern Finland. Questions remain over Nokia`s long term developments. Can they continue in what is after all a relatively expensive labour area when other cheaper well educated workforces, such as in nearby Eastern Europe, would provide a warm welcome? Moreover, now that Oulu has been explored as an individual case study, the way is now open for further comparative international research with experience elsewhere. For example Ideon, set up in 1983 in Lund, has been successful in pharmacy and biotechnology, compared to Oulu's success in telecommunications.

Finally, in 2002, a New Growth Agreement for further economic, social and industrial development was signed in Oulu by the City Council, an entrepreneurial strategy group and other public institutions. Careful monitoring of its implementation will be required to test whether it is simply a fragile hope or will it be the harbinger of further prosperity for the north. Clearly from past experience, the future of the region lies in its own hands.

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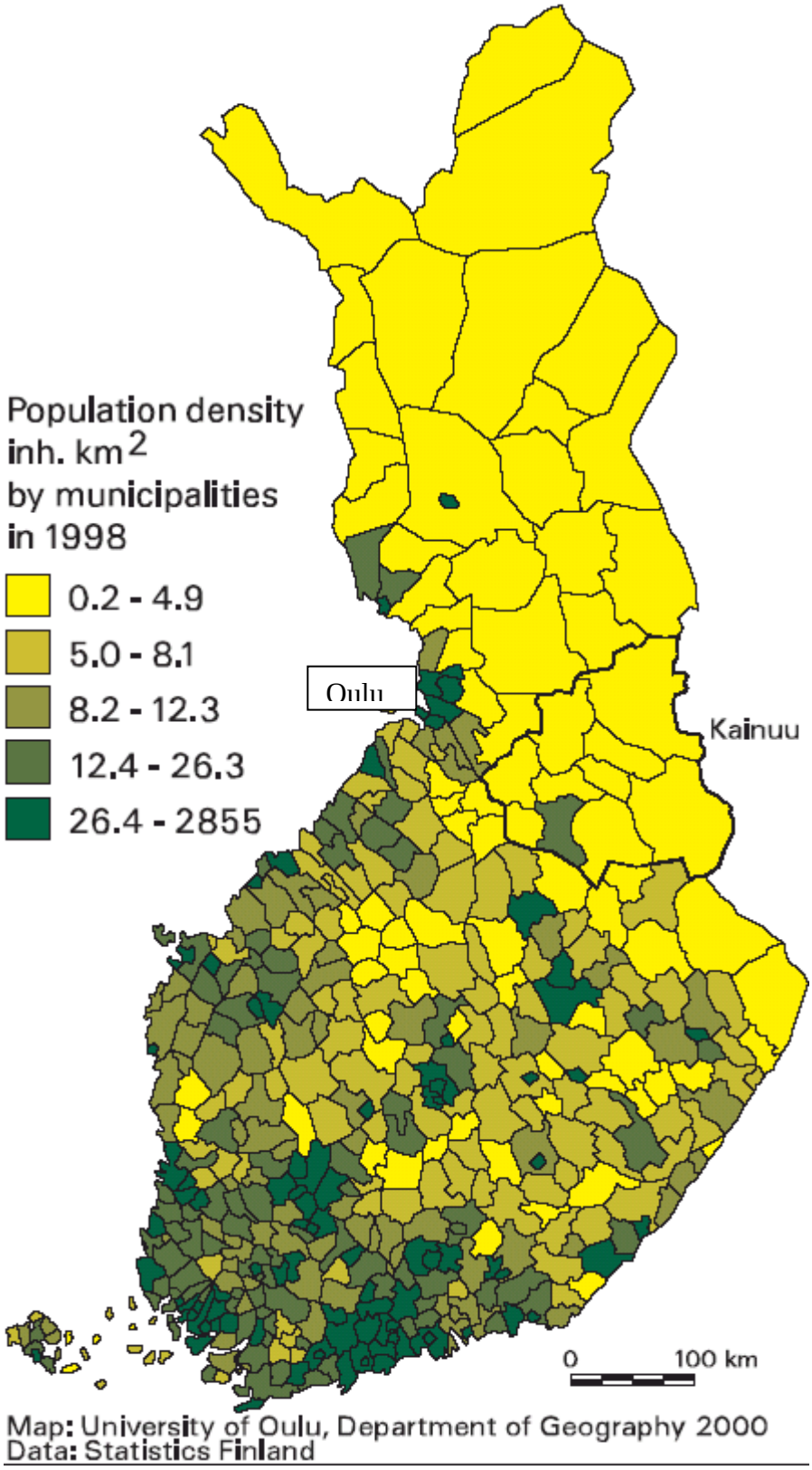
Appendix 1 Population Density in Finland in 1998



Appendix 2 The Map of Finland