DANISH RESEARCH UNIT FOR INDUSTRIAL DYNAMICS

DRUID Working Paper No 03-11

Entry by Spinoff in a High-tech Cluster

by

Michael S. Dahl, Christian Ø. R. Pedersen, and Bent Dalum

Entry by Spinoff in a High-tech Cluster

Michael S. Dahl, Christian Ø. R. Pedersen, and Bent Dalum

DRUID and IKE-Group
Department of Business Studies, Aalborg University
Fibigerstraede 4, 9220 Aalborg Oe, Denmark

Corresponding author: Michael S. Dahl (E-mail: md@business.auc.dk).

1st September 2003

Abstract
Recently empirical studies have focused on how capabilities of new entering firms are important for the evolution of industries over time. The performance of new entrants appears to be significantly influenced by their pre-entry background. The general impression of the literature is that firms founded by former employees of successful incumbents have shown larger propensities to survive than other categories of new entrants. In the present paper, we use this approach to study the emergence and growth over the past three decades of a wireless telecommunications cluster around Aalborg in North Jutland, Denmark (NorCOM). The aim is to analyse the dominating forces behind the growth of NorCOM using detailed information about the founding events and organizational background of the individual entrants in the cluster. We show that the technological successes of firms in the region have powered a spinoff process, which can account for the majority of the growth in number of firms and employment in the cluster.

Key words: Clusters, Spinoffs, Evolution of Industries, Entrepreneurs

JEL Codes: M13, L63, O31,

ISBN 87-7873-143-7

Acknowledgements
This paper benefited greatly from many discussions with Steven Klepper about the role of spinoffs in a geographical context and in the economy in general. His ideas are widely reflected in this paper. In addition, we are very grateful for comments from and discussions with Olav Sorenson, Toke Reichstein, Esben Sloth Andersen, and Ina Drejer. An earlier version of this paper was presented at the DRUID Summer Conference 2003, the NorCOM Association seminar, and at the DRUID Winter Conference 2003. We thank our discussants at these occasions, John Rice, Stefano Breschi and Piergiuseppe Morone, as well as the other participants for their valuable comments. Errors and omissions remain our responsibility alone.

1 Introduction

Do new firm formations and their organizational background determine geographical clustering of economic activity? Is the background of founders crucial for the survival and success of new organizations? Recent studies have shown how capabilities of new entering firms are important for the evolution of industries over time. However, surprisingly little attention has been paid to the background of the entrants. The few available studies all conclude that the histories of entrants have substantial effects on the survival and performance of firms (widely cited in the present paper). The main mechanism at work is that the capabilities of new firms are fundamentally shaped by the pre-entry experience of the founders (Helfat and Lieberman, 2002). Further, in some of the cases studies reported, the industries have been geographically concentrated. The degree of geographical concentration may have increased or decreased over time. Both features may be traced back to the background of the founders of new entrants combined with the degree of mobility of the labor force. In the literature, these two elements provide powerful contributions to explaining success as well as failure of industrial clusters.

In the present paper, we use this approach to study the emergence and growth over the past three decades of a wireless telecommunications cluster around Aalborg in the region of North Jutland, northern Denmark (NorCOM). The aim is to analyze the dominating forces behind the growth of NorCOM using detailed information about the founding events and organizational background of every individual entrant in the cluster. We focus on testing the argument that entrepreneurial spinoffs are likely to be more successful than other less experienced entrants given their higher level of industry specific knowledge and experience.

The next section presents the general theories behind spinoffs and their implications for the evolution of industries and geographical concentrations of firms. Section three contains a mapping of the genealogical evolution of NorCOM, followed by a more quantitative analysis of evolution. The implications of this study are discussed in section four and concluded in section five.

2 Entry and pre-entry organizational capabilities

Schumpeter (1934) has more than anyone highlighted the economic importance of the entrepreneur. His arguments have contributed to the generally accepted view that entrepreneurial activity is a wellspring of economic change and technical innovation. In the last twenty years or so, more and more empirical studies have emerged concentrating on entrepreneurial activities in primarily high-tech industries. However, only the most recent studies have focused specifically on the importance of spinoffs and pre-entry experiences (for references, see Klepper, 2001). This link between pre-entry capabilities and entrepreneurial activity is potentially very important for the survival and performance of the new firms.

All entrepreneurs bring knowledge and skills from their past working and educational activities that may be valuable in searching for new business areas and opportunities as well as in the daily life of running a firm (Shane, 2000). Thus, all entrants in an industry carry skills and rou-

tines embodied in the founders that are very likely to influence the new firm's future development and success. Often new firms enter the same industry in which their founders were previously employed. These cases are labeled spinoffs. Founders are likely to bring specific knowledge about a wide range of issues to their new firm, e.g. customer demand, products, technologies, suppliers and competitors (Helfat and Lieberman, 2002). This may also include knowledge about how to exploit new knowledge and technological developments based on unmet supplier or customer demands (Shane, 2000) or prior scientific and technical training (Roberts, 1991). Consequently, more experienced founders, e.g. entrepreneurial spinoffs, with valuable industry specific knowledge should have a higher probability of success compared with less experienced entrants. So it is very likely that the success of a new entrant is on the experience of the founder.

Organizational sociologists have for long considered the effects of the transfer of routines and experience between a new firms and its founder's previous employer (Phillips, 2002). The argument that blueprints of a parent firm are passed on to new organizations through the offspring's founders, is the cornerstone in a line of research by scholars such as Brittain and Freeman (1986), Carroll (1984), Hannan and Freeman (1986), and Romanelli (1985; 1989). The work of these scholars represented a brief, but very active line of research on founder's background in the 1980s (Phillips, 2002).

2.1 Types of entrants

There are different typologies of entrants in the literature based on their prior experience. In order to study the evolution of a particular case according to the different types of entrants, we must first select a relevant typology for distinguishing between different types. Klepper (2001; 2003) identifies four different groups of entrants. First, firms diversifying from related industries. The second is called the experienced entrepreneurs. They are firms founded by the heads or founders of already existing firms in the same industry. The third group is spinoffs in Klepper's terminology, founded by high level and experienced employees of incumbent firms in the same industry. And the last consists of inexperienced entrants with little or no experience relevant for the industry or founded by lower level employees from incumbent firms. However, there is an analytical overlap between some of Klepper's categories, such as between high-level employees and heads of incumbent firms. The separation of these two groups of people can cause some difficulties in distinguishing between 'experienced entrepreneurs' and 'spinoffs' in empirical case studies. Thus, we have merged these two in the typology put forward in Table 1 below, since we are not able to distinguish between the two types of entrepreneurs in our data.

Table 1: Typology of new firm entrants

Entrant type	Relation to established firm	Parent company ownership
(1) Diversifying entrant	Same firm	Full
(2) Parent-company activity	New firm as a separate entity	
- Joint venture	Founded by multiple established firms	Partial
- Parent spinoff	Founded by established firm	Partial
(3) *De novo* entrant	New firm as a separate entity	
- Entrepreneurial spinoff	Founder(s) previously employed in the industry	None
- Inexperienced startup	Founder(s) no prior experience or contacts in the industry	None

Source: Adapted from Helfat and Lieberman (2002, pp. 730-31) and Klepper (2001).

Helfat and Lieberman (2002) has presented another typology, which distinguishes between three main types of entrants: diversifying entrants, parent-company ventures and *de novo* entrants. (1) Diversifying entrants are firms entering new or established markets unknown to them, through acquisition or green field investment. (2) Parent-company ventures are new entities founded by established firms, either as joint ventures with other partners or as parent spinoffs.[3] (3) *De novo* entrants are divided into two different types based on their level of previous experience in the industry. This distinction is similar to Klepper's approach. Entrepreneurial spinoffs are characterized as firms founded by experienced persons with previous employment in incumbent firms in the industry. Persons with no previous employment in the industry have, on the other hand, established the inexperienced start-ups.

2.2 Spinoff theories

Despite the surprisingly little attention paid to the organizational backgrounds and origins of new firms in the 1990s, a branch of literature has emerged focusing especially on why and how spinoffs occur.[4] We summarize this literature below according to the division used by Klepper (2001). There are however several overlaps in these groups.

First, Klepper collects a group of theories labeled *agency theories*. Here, spinoffs evolve around the development of particular innovations (Wiggins, 1995; Anton and Yao, 1995; Bankman and Gilson, 1999). Innovations relate closely to the activities of parents and grow out of research undertaken by the parents. Spinoffs will occur, when employees pursue new technological discoveries made in his/her own firm. Wiggins (1995) and Anton and Yao (1995) add that the innovations are likely to be path-breaking and opening new sub-markets within the

[3] Helfat and Lieberman (2002) also included franchises as a parent-company venture. We have omitted this category, since it appears relevant mostly in retailing, which is not the focus of the present paper. We are studying a cluster of manufactures and developers of wireless communication equipment in which it is highly unlikely to see franchises as a form of entry. However, the category has its value in typologies with a more general theory in mind.

[4] For a comprehensive review of this literature see Klepper (2001).

industry. The work of new firms and organizations is related to activities of parents and is in some cases innovative and introducing new products or services to the market. In other cases, the new businesses of entrepreneurs will be more related to other existing firms than their parent (Romanelli and Schoonhoven, 2001). As an example, Romanelli and Schoonhoven (2001) highlight that the scarcity of technical personnel in Silicon Valley and northern Virginia in the late 1990s has prompted many new high-tech personnel search organization startups founded by former employees from the human resource departments of existing high-tech companies. So it may sometimes be the case that new firms will predominately exploit the commercial promise of technological and organizational innovations, but they will not necessarily be a predominant source of new innovations themselves (Schumpeter, 1934).

Second, a spinoff may also be the result of *organizational problems or inertia* in the parent firm (Cooper, 1985). If the incumbent has difficulties of an organizational nature, the employee is likely to have less difficulties leaving the firm and taking advantage of the missed opportunities. Examples of such a crisis is when the incumbent is acquired by another firm, when a new CEO from outside has been appointed, or when a firm experiences decreasing economic performance (Brittain and Freeman, 1986). But Klepper also includes radical innovations not pursued by the mother firms in this category, which may lead to some overlap with the agency theories referred above. The existing management may not be willing to commercialize new important breakthroughs. Accordingly, spinoffs firms are likely to pursue innovations, which are architectural (Henderson and Clark, 1990), competence-destroying (Tushman and Anderson, 1986), opening new submarkets or minor innovations involving modest capital and business plans (Bhide, 2000). All the theories assume that these are innovations that the parents are not going to pursue. For these reasons, spinoffs are not likely to be considered a competitive threat. The study by Tushman and Anderson (1986) showed that existing organizations will tend to exploit innovations that are more closely related to their primary forms of work in cases where the innovations are competence enhancing. However, in cases where the innovations of the firms are competence destroying, new firms will emerge (as spinoffs) capitalizing on the innovation. Although Tushman and Anderson did not directly study the background of these emerging firms, there is evidence that the firms tend to be founded by employees from existing organizations. For instance, one of the cases referred to is the evolution of the minicomputer in relation to the mainframe industry studied by Romanelli (1985), who found that the majority of the producers of minicomputers had previously been employed in mainframe computer companies that had declined to enter the emerging market of minicomputers (Romanelli and Schoonhoven, 2001).

Third, *employee learning* can also play an important role in spinoffs. This implies that spinoffs will exploit the opportunities of their parents by entering with a product similar to the one they worked with at the parent. Consequently they either compete directly with their parent or more narrowly with one of the parent's activities (Franco and Filson, 2000; Klepper and Sleeper, 2002). The entrepreneurs may be motivated to found a competing firm, when the growth of their current employer indicates a substantial demand for its products and services. Growth, especially very fast growth, can indicate the presence of an unmet demand and thus great market opportunities for additional competitors (Romanelli and Schoonhoven, 2001). Similarly this

approach implies that more successful and innovative firms with broader product lines also will spawn more spinoffs, since they form inspirational learning environments for their employees. Garvin (1983) and Cooper (1985) argues that since spinoffs usually are of a small size initially, small firms will have higher spinoff rates, because they act as the most valuable lessons for their employees on how to start their own firms. They also conjectures that regions, which have many firms in a particular industry, will also have higher spinoff rates, because of the high supply of qualified labor in that industry.

Finally, the theories of the *heritage of spinoffs* have important predictions regarding the role for further evolution of a given industry. Cooper and Gimeno-Gascon (1992) argue that the heritage and background of a spinoff will have vital effects on its performance. Spinoffs with founders, who have experience from a parent organization in a similar industry, are likely to have more valuable experiences to draw upon in the new firm. This will consequently lead to better performance. Also, employment in a growing and successful organization will be an advantage for potential entrepreneurs, as they might be better able to attract financial and human resources for creating a new organization. We can therefore expect that the majority of the new firms founded by former employees of growing companies will to a large extent replicate not only the primary work of the parent, but also the way the daily business and organization is carried out. Because of the significant risks involved with founding a new firm, simple replication of a growing parent may be the best way to reduce the risk of early failure (Romanelli and Schoonhoven, 2001). Dyck (1997) claims that in some instances spinoffs are planned and supported by the parents. With this help from the parents, planned spinoffs will outperform unplanned and thus unsupported spinoffs.

There are overlaps between these theories. According to the first group of theories, spinoffs can be a result of new discoveries and innovations made at the parent organization leading to a product, which is different to the ones already produced by the parent. In principle this is very close to the arguments of the third group, the theories on employee learning. Employees will harvest on the learning processes and experiences from the parent firm to found their own, although usually with products similar to the parent. However in the second group, spinoffs are founded as a result of organizational issues e.g. a new management team, missed opportunities or disagreements. Missed opportunities can also be an underlying reason in the first group of theories, where spinoffs happen due to the discovery of new opportunities not being pursued by the parent.

Phillips (2002) argues that life chances of a parent organization decrease, especially when higher ranked employees leave to found new firms. The transfer of knowledge and routines is larger from the parent to the entrepreneurial spinoff, the higher the founder was previously ranked. A 'parent-brain-drain' like this represents a disruption in the routines of the parent, which clearly effects the future of the firm. Furthermore, Rajan and Zingales (2001) argues that higher ranked employees are likely to take lower ranked employees with them to their new organization. This is also likely to decrease the life chances of the parent. However, as time goes by after the separation of the progeny, life chances of the parent increases again, since the routines are rebuilt and stabilized. In his analysis of the Silicon Valley law firms, Phillips (2002) found that the transfer of resources and routines between parent and progeny decreased the life

chances of the parent, but increased the new organizations' chances of survival. If a new organization has founders from more than one parent, they were more likely to fail than otherwise. This result from Phillips' analysis suggests that a mix of routines and experiences from different parents are likely to decrease the performance of the new organization.

2.3 An evolutionary account for spinoffs

Klepper (2001) exploits the metaphor of spinoffs as children and employers as parents in his evolutionary account for spinoffs. In addition to the theoretical approaches summarized in section 2.2, he proposes a model that combines the ideas of reproduction and inheritance with the notion of organizational routines. This notion is originally developed by Nelson and Winter (1982) assuming that firms are to a large extent governed by routines. A firm has separate routines for the different functions (R&D, marketing, management, etc.) and products involved in its operation. Either the founders or the initial management team install these routines. Decision making at all levels will subsequently depend on them. When a new firm is born organizations will reproduce, because founders will rely on routines, which they are already familiar with from their previous employment experience.

The quality of these routines will determine the future success and performance of the new firm. Entrepreneurial spinoffs may inherit more suitable routines than any other kind of startup, because of the experience of the founders. This may on average enable these spinoffs to outperform other startups. Eventually the longer survival and better performance of entrepreneurial spinoffs will one day turn them into parents, since employees with access to better routines will be more likely to found new organizations (Klepper, 2001). Capabilities of new firms are fundamentally shaped by the experiences of the founders (Helfat and Lieberman, 2002). Thus, better performing firms will spawn more spinoffs.

When a firm grows and takes on new technologies and products the organizational routines will change, which will influence the performance of the firm. It will diverge further and further from its starting point and its parents. The firms will become less similar and so will their performance. Changing routines will change the choices made on product development and innovation. In other words, entrepreneurial spinoffs will be a source of diversity as they develop more distinctive innovations over time – they will thus stimulate the rate of technological change in an industry. A common denominator of the research so far is that leading firms in industries may risk losing their dominant position to new entrants (especially entrepreneurial spinoffs) when faced with radical innovations. Given their past success, leading firms may not see critical deficiencies in their resource profile and routines necessary for changing markets (Helfat and Lieberman, 2002).

The average competences of diversifying firms are assumed to be greater than the average competences of the new firms given more comprehensive organizational experiences and complementary assets. But if the organizational challenges facing an industry are novel and sufficiently complex, the new firms may be able to reach or exceed the average competence level of the diversifiers, since new firms tend to have more flexible routines towards the demand challenges and changing conditions. Inexperienced firms will not be able to compete with any di-

versifier or spinoff, because they lack the sufficient experiences. If organizational challenges are not novel, diversifiers are more likely to be dominating the industry (Klepper, 2003).

To illustrate how the theories of spinoffs can contribute to a better understanding of geographical clustering, we look at the evolution of three industries studied in such a context. The evidence from the US automobile, US semiconductor, and US television receiver industries fit well with the hypothesis that pre-entry experiences and inherited firm capabilities can explain the performance of firms over time.[5] But this said the evolution of the three industries was fundamentally different with respect to which firms ended up dominating the industry as well as how the geographical structure evolved over time.

First, the *automobile industry* was characterized by a large rate of entry with more than 500 firms entering in its first 20 years (Carroll *et al.*, 1996). However after 1909, the industry went through a tremendous shakeout until 1941. In this period the number of firms steadily decreased, dropping from 272 firms in 1909 to only 9 in 1941. The industry evolved to be a tight oligopoly dominated by three relatively late entering firms, Ford, General Motors and Chrysler. All of these came out of Detroit and their success can be explained by the pre-entry experiences and capabilities of the entrants. Many of these entrants were spinoffs and most of them, especially the most successful ones, can be traced back to the very successful early entrants that happened – somehow by chance - to locate in Detroit (Klepper, 2002). The new firms were able to rely on the superior performance of their parents to become successful themselves and dominate the entire industry. This cannot explain the initial location of the four large producers in Detroit and why they became successful, but given the chance of this occurrence, Klepper's theory can indeed explain why the firms founded in that area in the following years became so successful.

Second, many studies of the *semiconductor industry* have shown that entrepreneurial spinoffs and employee mobility have been important factors in the evolution of this fields. As Dosi (1984) notes, founders of new firms in the early years very often worked as scientists or managers in existing semiconductor firms. Brittain and Freeman (1986) and Moore and Davis (2001) even argue that entrepreneurial spinoffs were the main engine behind the growth in Silicon Valley. The most well known case is the many firms that spun off from Fairchild Semiconductor, often called the 'Fairchildren'. Fairchild Semiconductor was in fact itself a spinoff of Shockley Transistor[6]. In general, engineers left established incumbent firms in large numbers and started new ventures that produced the capital goods and materials needed for semiconductor design and manufacturing. The majority of the new firms were founded in Silicon Valley where the technical expertise was already abundantly present, founders had the contacts to recruit talented employees, and an effective venture capital system was ready to provide the

[5] Helfat and Lieberman (2002) point to several similar studies, which all confirm this. Among these are Chatterjee and Wernerfelt's (1991) study of the US manufacturing industries, Mitchell's (1989; 1991) study of the US digital imaging industry, and Thompson's (2002) study of the US iron and steel shipbuilding industry, which all conclude that pre-entry experiences of diversifying entrants, and sometimes entrepreneurial spinoffs, enhance post-entry performance. To these we might add that other industry studies also confirm this, e.g. the footwear industry (Sorenson and Audia, 2000), lasers (Klepper and Sleeper, 2002), tires (Klepper and Simons, 2000b), and the disk drive industry (Christensen, 1993; Franco and Filson, 2000; King and Tucci, 2002).

[6] Shockley Transistor was also a spinoff. It was founded in 1955 by the co-inventor of the transistor William Shockley in 1955. He previously worked for Bell Telephone Laboratories.

critical early financial support for founding a firm (Romanelli and Schoonhoven, 2001). In the early years of the industry the technology itself was not well understood by most firms, and they basically also had to produce their own production equipment. As a result, semiconductor firms faced novel organizational challenges in aligning goals and designing the organizational structure that could establish and reach the technological demands of the industry. Working for incumbent firms was the best way to learn how to tackle those challenges. Consequently, entrepreneurial spinoffs were uniquely able to perform well in the industry (Moore and Davis, 2001). They were often founded as a result of fundamental disagreements concerning strategic changes within in the incumbent firms (Brittain and Freeman, 1986).

Third, Klepper and Simons (2000a) study the prior experiences of potential of entrants - i.e. radio manufacturers - in the *TV receiver industry*. The radio manufacturers are interesting, because they came to dominate the evolution of the TV industry although they were only a minority among the entrants. Radio manufacturers entering early survived longer and gained, on average, larger market shares than non-radio producing entrants. In fact no non-radio producer ever gained a considerable share of the TV market. In the early years the US television receiver industry was concentrated around three cities, Los Angeles, New York and Chicago, but further on Chicago firms became the leaders. Most of them had previous experiences in the radio industry and were founded as either parent or entrepreneurial spinoffs. During the shakeout in 1951-58 the Chicago region became the winner, as the New York and Los Angeles manufacturers gradually exited the industry (Klepper, 2003).

The evolution of the TV industry has been distinctly different from semiconductors and autos. In autos, even entrants from related industries (carriages, wagons, engines, etc.) were facing much more novel organizational challenges (Klepper, 2003). They could not rely on the knowledge and organizational routines from related activities, since the development and production of automobiles was very different from producing carriages, wagons or engines. It was a similar pattern in semiconductors. There were no related industries that semiconductor firms could have diversified or spun off from, taking their routines and organizational knowledge with them, because producing semiconductors was so inherently different from anything else at the time. Entrants in this industry had to develop the routines themselves coping with the novel organizational challenges facing them. The best way to learn how to do this was to work in an incumbent semiconductor firm.

These three cases illustrate a core argument of Klepper's theory. The evolution of industries is closely related to the challenges facing entrants. If an industry is closely related to an already existing one, the best firms from the latter are likely to end up dominating the new one. In such a case the geographical distribution of firms is likely to be the same. That happened in TVs. The best radio firms were located in Chicago and they were the ones able to perform in TVs as well and outperform the TV firms in Los Angeles and New York. In autos and semiconductors, entrants faced novel challenges very different from those facing other industries. Consequently, entrepreneurial spinoffs of early high performing entrants were the firms surviving in the longer run. Such spinoffs were much more capable of handling the new conditions. This determined the geographical distribution of these industries, since the successful early entrants located – basically randomly - in Detroit (autos) and in Silicon Valley (semiconductors).

2.4 The local and social dimension of entrepreneurial activity

The phenomenon of the most successful entrants having 'inherited' significant amounts of experience from existing firms implies that entrepreneurial activity has a considerable geographical aspect, since the majority of entrepreneurs may tend to found their new firms in close proximity to their previous employers (Sorenson, 2003). The local 'production' of new entrepreneurs, thus, plays a vital role for regional development. New jobs are not only created in incumbent firms but indeed also by the formation of new employers through local spinoff mechanisms.

This does not necessarily imply that founders will only base their new organizations in close proximity to their past employer. There are well known examples of founders, who search for the most proper location among many geographic regions, that either provide access to a large local market or, perhaps more important, offers the best selection of resources to the organization.[7] Today, it is hard to argue that potential founders only have knowledge about their own local environment and the local entrepreneurial opportunities (Romanelli and Schoonhoven, 2001). But the current geographical distribution of an industry places important constraints on entrepreneurial activity (Sorenson, 2003). Important resources for new organizations, such as abundantly available technical personnel generally tend to be immobile and unevenly distributed across geographical space. Thus, founders tend to base their new organizations close to previous employers, since they have detailed knowledge about and social connections to available resources in that particular region.

According to Sorenson (2003), the process of founding a firm includes two stages. Each of these closely ties social networks to entrepreneurship. First, an entrepreneur has to be able to *identify the opportunities* for founding a new firm. In order to do this, the entrepreneur has to access knowledge about the conditions of the industry in question. Incumbent firms will naturally try to conceal their knowledge about strategic decisions and profitability of their operations, which may tempt others to enter their market segment. However, many employees from the higher ranks in incumbent firms already have access to this knowledge. This enables them to become entrepreneurs themselves or disclose the information to others in their social network. In addition, if a region contains several firms in the same industry, entrepreneurs will tend to occupy positions in communication networks enabling them to access knowledge about market conditions and identify promising development opportunities more broadly (Sorenson, 2003). This will increase the likelihood that their firms succeed. A broad stream of empirical research confirms that social networks acts as communication channels for this type of knowledge (see e.g. Von Hippel, 1987; Rogers, 1995; Dahl and Pedersen, 2003).

The second stage is to actually *build the new organization*. In order to complete this stage the entrepreneur needs to have access to three elements: industry-specific tacit knowledge, human capital, and financial capital (Sorenson, 2003). Social network relations can facilitate the acquisi-

[7] For example, Jeff Bezos, the founder of Amazon.com, chose Seattle as the best location for founding the firm in 1995, because of the high concentration of local technical talent (Seattle being the home town of Microsoft and a growing number of spinoffs) and the close distance to the largest book warehouse in the world located in Roseberg, Oregon (Romanelli and Schoonhoven, 2001).

tion of each of these elements. The new firms that are able to access industry-specific tacit knowledge have large advantages (Klepper, 2001; Klepper and Sleeper, 2002). This knowledge is an important source of prosperity to those that hold it, because it is extremely difficult to replicate. The entrepreneur requires strong social ties to the holders, since there are considerable issues of trust involved in accessing this knowledge. Furthermore, industry-specific tacit knowledge resides in incumbent firms as embodied knowledge in employees. Consequently, new firms virtually hail from the ranks of current employees in incumbent firms (Sorenson and Audia, 2000).

Another way to access this type of knowledge is to hire employees that hold it. Since the future of a newly founded firm is uncertain, it takes considerable persuasion to attract new labor from secure conditions in incumbent firms. Potential employees are not likely to move away from their secure positions, if they do not trust or have confidence in the abilities and judgment of the founder (Sorenson and Audia, 2000). In this process, social relations can facilitate the trust necessary in order to attract and obtain the human capital from the labor market.

Social connections also play a vital role when accessing financial capital for founding a firm. Founding a firm involves a series of risks and it is fundamentally an uncertain process. Even the magnitude of the risks is uncertain. Studies show that even risk-neutral investors exhibit ambiguity aversion, if they are unable to quantify the risk of an investment (Fox and Tversky, 1995). Hence, potential investors are likely to view the opportunities of new firms with considerable suspicion unless the investors are socially connected to the entrepreneur. An entrepreneur is more likely to find financial capital, if she has social ties to the investors, because they are more likely to trust her judgments of the risks and opportunities involved. Consequently, entrepreneurs are most likely to be tied to the region, where they have useful social relations, even if another region is otherwise more attractive (Sorenson and Stuart, 2001).

We argue that the benefits of social networks increase as employees gets more experienced and climb the occupational ladder. If this is the case, the likelihood of success for a new firm increases with the experience and social connections of its founder, because she has better opportunities to successfully complete the two stages of entrepreneurship. This means that entrepreneurial spinoffs are more likely to be successful than entrants with lower levels of experience and local industry knowledge.

Other social issues are also like to play a part in the location decisions of founders of new firms. They have strong social ties to a specific location through the employment of their spouse, the school of their children etc. This may also prevent them from leaving the region. So in general, we might expect that clusters of new firms in a particular industry continuously evolve in regions, where human and other resources are abundantly present and where entrepreneurs are produced at a large scale in the incumbent firms of the industry. If all of this is the case, the existing structural base of a region is a dominant source of the geographical concentration of industries and regional economic growth. But which factors determine where the initial activities of a new industry are located?

The initial activity is often seen as being located in a particular geographical location by chance (Arthur, 1990). This could be a single *de novo* entrepreneur (entrepreneurial spinoff) or a

single diversifying local organization. Arthur (1994) highlights the claims of Engländer (1926) and Palander (1935) that historical and chance events would have provided a location structure; and that inherited structure combined with agglomeration tendencies would determine the future settlements in a region. New industries will be laid down layer by layer upon inherited structures through the phases of development. In an evolutionary perspective, agglomeration can be interpreted as the mechanism by which existing organizations will breed the new ones founded by entrepreneurs.[8] New firms in a region will mainly emerge from the existing ones as entrepreneurial spinoffs. The immobility of labor as a result of social and economic forces will induce entrepreneurs to locate close to their origins, so they can maintain their social ties and continue exploiting their localized knowledge of capitalists, potential employees, and suppliers. As a consequence, the quality of the new organizations and the future development potential in a region at a given time, will be a function of the quality of the stock of existing firms and past entrants (Klepper, 2003). This is in line with Romanelli and Schoonhoven (2001), who argue that most new firms will be founded in the same geographical region, or very close to it, as that of the firm that produced the entrepreneur. Only few entrepreneurs will be attracted to another region because of available technical and market expertise and other resources. Entrepreneurs will more typically be produced within the region itself by existing organizations. This means that a region's future will be closely determined by its present structure and profile.

3 The role of new firm entry in the history of the NorCOM cluster

The evolutionary approach outlined above is applied in the present section on the development of a fairly small cluster of high technology based firms in the field of wireless communications in the region of North Jutland, Denmark.[9] Defined narrowly, it consists of around 50 firms, a science park (NOVI) and Aalborg University (AAU), which contains one of the two major technical universities in Denmark as its Faculty of Engineering and Natural Sciences. The relative small size of the cluster has facilitated more easy information access and has made it possible to study an entire cluster over more than three decades.

3.1 The history

3.1.1 Early success of S.P. Radio

The success of S.P. Radio (established in Aalborg in the 1940s) in the 1960s and 1970s as one of the world's leading producers of maritime communications equipment gave the employees, who was the founders of the first spinoffs in the 1970s, the relevant capabilities and routines to become successful themselves. S.P. Radio is usually acknowledged as the main parent company

[8] Arthur (1994) have argued that similar organizations with a somehow different background and from other regions will be attracted by the growing presence of activities. This tradition goes back to Weber (1928).

[9] For an account of the early development of this cluster, see Dalum (1995). More recently several studies have focused on various features of this cluster. Dahl and Pedersen (2003) have studied the informal networks, Dahl (2003) has studied inter-firm mobility of labor, Dalum, Pedersen and Villumsen (2002) have discussed the potential technological disruptions facing the cluster in a life-cycle context, and Lorenzen and Mahnke (2002) have studied the effects of acquisition activities by multinational corporations.

in the NorCOM cluster. Simon Petersen, a newly graduated engineer, started a consumer radio retail business in Aalborg around 1930 and soon after he began manufacturing radio receivers himself. After World War II he started S.P Radio A/S, and increased the production of consumer electronics. In his spare time, Simon Petersen was a yachting enthusiast, and through this hobby he got the idea of producing radios for maritime use in yachts and small fishing vessels. S.P. Radio produced the first radio in 1949, but they did not start to produce radio communication equipment for maritime use (receivers and transmitters) until the early 1960s. The company had grown steadily since its establishment, but in the 1960s there were more than 30 producers of consumer electronics in Denmark and Simon Petersen saw that the industry was reaching a saturation point facing fierce competition. Large producers largely neglected the market for radio communication equipment to small vessels, so there was nearly no competition in this area. Consequently, S.P. Radio stopped producing consumer electronics and diversified into developing and producing maritime communication equipment in the mid-1960s. This became an almost immediate success. The equipment was technologically very advanced compared to its few competitors. The price was competitive, since there was not much use of mass production at the time in this industry. After a few years S.P. Radio was one of the world's leading producers of communication equipment to this segment. In 1966, the company had 150 employees, high exports and continued to expand its product line into the market for larger vessels.

S.P. Radio continued its success and grew in the 1970s and 1980s and was the largest communications firm in North Jutland in these years. In 1973, the first spinoff firm Dancom was founded by three engineers from S.P. Radio. One of them had been the head of R&D of S.P. Radio for four years. There is no record of why they started their own firm, but newspaper articles and literature indicate that Simon Petersen were very controlling and had a bad temper. This has definitely influenced the creation of the spinoff. Dancom was active in the same markets as S.P. Radio producing maritime communication equipment and later on also in closed mobile systems for onshore use.

A few years later in 1977 two experienced engineers working at Dancom decided to start Shipmate (named Rauff & Sorensen after the two founders in the first few years) in the washing room in Sorensen's basement. The first product was a radiophone for maritime use, which competed directly with both Dancom and S.P. Radio. Their product sold very well and funded the development of the next version, which was a large breakthrough for the company. In 1980, further success came after a boat exhibition, where they got the idea to develop a satellite navigation system. At that time the firm only had one employee besides the two founders. But they were still able to develop a complete navigation system at 1/3 of the price of the competitors in only one year. Shipmate successfully developed and produced radiophones and navigation equipment for maritime use. Five years later the firm had reached 200 employees.

Dancom went into financial difficulties in 1980. The founders were suspended from their duties as managing directors. The firm was reconstructed under the management of Henrik Langkilde, who was brought in by the creditors. Before that he had written a 300-pages report as a consultant for Dancom. They wanted to explore the possibilities for using the firm's capabilities and advantages from maritime communication in an emerging market of onshore personal

communication. The report was a complete overview of the worldwide wireless communication industry including an assessment of its future development and market potential. The reconstruction of Dancom was a turbulent period for the people in charge. The firm was located in the small community of Stovring, south of Aalborg, and they were constantly followed and confronted by employees wanting to know more about their future. Consequently, they decided to move the firm to Pandrup, north of Aalborg, where a smaller components division of Dancom was already located.[10] Langkilde successfully reconstructed Dancom on a smaller scale focusing only on closed onshore mobile communication systems. Shortly after, the firm started activities in producing personal mobile phones. In 1982-83, Dancom changed its name to Dancall Radio and shortly after it went public on the Danish Stock Exchange.

After the reconstruction, one of the original founders of Dancom, Svend Hansen, continued the maritime activities, when he founded Danish Marine Communication. He bought Dancom's old buildings in Stovring and hired some of the fired employees. [11]

3.1.2 The success in the first generation of mobile telephony

In the early 1980s some of the cluster firms and spinoffs (especially Dancall) diversified into an emerging technologically related area of personal mobile communication equipment. These new firms eventually started the second wave of success. They diversified into mobile communications as the market opened by the introduction of the common Nordic standard for mobile telephony (NMT). When the market boomed during the 1980s, these firms were successfully among the world leading producers of phones for this network. They were able to use the inherited and developed capabilities from the maritime radio communication equipment to diversify into mobile phones.

In this first generation of mobile communication, most countries had their own system based on different standards. Only the Nordic countries had a common standard. This is often argued to be one of the reasons for the success of the Nordic mobile phone producers. At the global level, the entrants of the mobile communication equipment industry in mobile communication technology came from many different technologies related to electronics. However, a major group of entrants were from either radio or network technology, of which the latter group has been the most successful (e.g. Nokia, Ericsson, and Motorola).

In 1985, Shipmate expanded into mobile communication with the new activities placed in a parent spinoff, Cetelco (with one of Shipmate's founders as technical manager). A year later they had developed and produced their first mobile phone. The reason for establishing Cetelco was to produce NMT phones, which had a fast growing market, but also to build up production capacity for mass production, that could reduce the costs of the maritime products. After two years Cetelco had 25 engineers working with R&D. They developed and produced mobile

[10] The component division was located in Pandrup, because of regional development subsidies.
[11] Other firms emerged in the early 1980s: Lasat (1982), an inexperienced entrant (founded by newly graduated engineers from Aalborg University), produced modems for wired telecommunications networks, and Niros Telecommunication Development (1985), a parent spinoff headed by engineers from Danish Marine Communication (1980-87), founded as a development department of a Danish firm, focused on radio communication. LH Agro was founded in 1976 as a parent spinoff of a local electronics firm focusing on communication systems for agricultural use.

phones for several European and East Asian countries. The tremendous success of NMT had made other countries adopt the system, albeit in slightly different versions. The NMT network was cheap to build in comparison with the more advanced systems, which was introduced in Western Europe in the beginning of the 1990s, so it continued to be the preferred system in particular in the Eastern European countries, the Middle East and Asian countries into the mid-1990s.

The cluster firms had high growth due to their successful diversification into mobile telephony and North Jutland became visible as a NMT region, but in the last half of the 1980s the market changed. The phones had undergone rapid technological development. From being relatively heavy, more or less portable (bag-like) terminals often installed in cars, the phones became much smaller and handheld. The small cluster firms were facing an international market with high development costs, production capacity demands and price competition, but they still managed to grow, since the local factor conditions were favorable. In newspaper articles from late 1980s, representatives of some firms stressed the importance of a large group of unskilled labor (the region had a 20% unemployment rate) with many possibilities for in-service training and the presence of a local university as particularly favorable conditions. However, there were severe problems attracting qualified and experienced engineers from other parts of the country. An engineer, who moved from Storno, a wireless communications firm in Copenhagen and later founded a spinoff, confirms this. He claims that it was not attractive to move to North Jutland to get a job at Dancall in the early 1980s, because there were only a few firms to work for.

In 1987, seven experienced engineers from Dancall founded T-Com. The engineers disagreed with Dancall's overall market strategy and decided that they could do it better themselves. T-Com's strategy was to develop NMT mobile phones just like its parent company, but differed by only focusing on R&D as a subcontractor. Other companies would then produce and market the phones under their own brands. In the same year, they developed their first mobile phone (produced and marketed by the French firm Alcatel). The firm focused on developing small, light, and advanced terminals. T-Com was very successful and after two years it had developed versions for all the different standards in the world. The company was first sold to British C-Com in 1990, but only one year later Maxon acquired it. Maxon from South Korea wanted to enter the market for mobile phones. The new Danish division of Maxon continued to develop NMT phones until 1995, because the NMT market continued to be large in Northern and Eastern Europe, the Middle East, and Far East Asia.

In the last half of the 1980s, there were a total of 15 firms in the industry in Northern Denmark. One of the entrant firms had been closed, but new firms had continued to enter. The majority of these were spinoffs.[12]

[12] These were: ETI Telecom (a Lasat spinoff in 1985), Ammcom (a Dancall spinoff in 1986), BD Consult (a Cetelco spinoff in 1988), and Spacecom (a Thrane & Thrane (Copenhagen) spinoff in 1989). There were also two inexperienced entrants, Digianswer (who first was successful in developing a digital answering machine for the mobile phone and later a combined telephone and fax. Founded in 1986) and Force Electronics (developing and producing communication analysis and satellite equipment. Founded in 1989).

3.1.3 The success in the second generation of mobile telephony

The third phase of success started when the common European standard for mobile telephony (GSM) was introduced as a new standard. The success of NMT inspired the European telecommunications operators to create a European system based on digital technology. A race began between the leading producers in the world to be the first to be able to produce a complete terminal for this network.

The challenge of building a GSM mobile phone was seen to be a major economical and technical challenge for the mobile communication firms, since it was based on new digital technology. To cope with this, the two competitors Dancall and Cetelco formed a pre-competitive joint venture company, DC Development, with the purpose of building the basic modules of a GSM mobile phone in close corporation with the Department for Electronic Systems at Aalborg University. The companies should develop the rest of the phone (display, design etc.) themselves. T-Com/Maxon was also a part of the planning process, but decided not to join and continued to focus on the NMT phones. DC Development was founded in 1988 and located at a new science park, NOVI, close to Aalborg University. They participated in the international GSM standardization and specification process, since the specifications were determined in parallel with the development of the terminals. In 1990 the cooperation was increased to also include setting up the first production lines. Dancall focusing on the radio print and Cetelco on the digital part, which combined are basic elements in a GSM phone. This was a large technical challenge, since they had to develop and design their own automatic test equipment. DC Development succeeded in the development of basic modules and the parent companies were among the first to produce a GSM mobile phone in 1992. In spite of the achievement and talks during this period of making DC Development a permanent establishment, the companies decided to end their cooperation. DC Development employed at the peak almost 30 engineers and the group was divided equally between the two firms after the closing. The success increased the international visibility of the cluster and strengthened the region's reputation in wireless communication technologies.

The market changed as multinationals entered the GSM market with increased competition, falling prices, rapid development and increased demand for volume production as a consequence. The high development costs of NMT and GSM phones put Dancall and Cetelco into severe financial problems in the early 1990s, because they did not have enough financial backup to harvest their discoveries.

As a consequence, Cetelco was gradually taken over by Hagenuk (Germany) in 1988-90. Hagenuk wanted to enter the GSM market. Cetelco continued to grow afterwards (from 100 to 250 employees), but had too high development costs compared to its income. This became a problem already in 1993 with their first GSM phones, which were expected to last 15 months in the market, but only lasted 9 month. In 1995 when Cetelco launched the second version GSM phone, the development period was miscalculated, the phone was too big and expensive compared to competitors, and as a result the firm had downsize the production and the number of employees dropped to 150. During the late 1990s, Cetelco stopped producing mobile phones and was only an R&D division of Hagenuk. In 1998, Telital (Italy) took over the division, but

only three years later the problems were back. In December 2002, the firm was finally closed down. Some of the employees were immediately hired in bunches by other local firms and a new firm, Advanced Wireless Design (a parent spinoff of a Hong Kong based firm), was established with ten former employees.

Dancall had more than 600 employees in early 1993.[13] But the newly produced GSM phone was too expensive compared to competitors and at the same time the export of NMT phones suffered from declining markets. Consequently, Dancall had severe financial problems and the firm sold off their cordless telephony division as Cortech.[14] Now the only activity of the firm was mobile phones. But this was not enough and the firm still had to suspend its payments. Dancall was reconstructed with fewer employees and sold to Amstrad (United Kingdom). During the next couple of years, the firm grew larger than before the reconstruction. In 1997, Robert Bosch (Germany) acquired it. Bosch used the acquisition to enter the GSM market and continued the expansion to 1400 employees in 1999. In 2000, Bosch realized that it was too small a player in the industry and the firm decided to cut off its mobile phone activities. It ended up splitting the Danish division into two parts. Siemens (Germany) acquired the R&D department and Flextronics International (United States) bought the production facilities. During the transition period with changing ownerships many engineers moved to other local firms. Some of them also founded new firms.[15]

Several spinoff firms were founded throughout the 1990s. Gatehouse (founded in 1992 – spinoff from Dancall) began as an independent software company and worked as a subcontractor for several other local firms from the beginning. It started out in GSM mobile phones, but gradually expanded into other technologies opening up the local market. The company has continued to grow and had 22 employees in 2002. In 2003 the expansion has continued through the acquisition of a small local competitor, PB Radio. PB Radio was founded in 2001, when a group of engineers spun off from Eurocom Industries (S.P. Radio).

Although mobile and maritime communication technologies were dominating activities in the local industries, other wireless technologies thrived as well. Among these were cordless telephones for regular wired telephony. Within this field, Danish DECT Development was founded in 1993 as a joint venture between nine communication companies (four of them were local). The purpose was to work on a further Danish development of the specification on the new European standard for cordless phones, Digital European Cordless Telephony (DECT). The standard was rather unspecified and further work was needed in order to actually produce phones from this standard. The purpose of the joint venture was to help the small Danish firms and to give them first mover advantages by providing them with results from field experiments and test of prototypes. Although DECT mainly was supposed to be for speech it also included

[13] In 1990, Dancall focused only on mobile and cordless phones. The production of closed mobile radio communication systems was separated as Danphone in a joint venture with a local electronics firm.
[14] DeTeWe from Germany bought this part. Cortech had success during the 1990s and continued to grow. In 2001, Rohde & Schwarz (Germany) acquired it with the focus of developing test equipment for wireless communication equipment.
[15] For instance TTPCom, which was founded in 2001 by three experienced engineers from Siemens. They wanted to startup themselves, but chose to start up a Danish branch of TTPCom (UK), developing e.g. software and games for mobile phones.

data transmission. After completing its task, L.M. Ericsson (Sweden) acquired Danish DECT Development in 1995 and renamed it L.M. Ericsson Danmark. The firm continued working with DECT cordless telephone technology. Later it expanded into mobile telephony and other wireless technologies. At its peak in 2000, there were 130 employees. In the late 1990s, the Danish division in Aalborg was appointed to be one of L. M. Ericsson's main development centres for the next generation of mobile phones. This increased to local expectations regarding the future employment potential, but then the telecommunications crisis hit. The firm was cut down in successive steps.[16]

In 1993 three experienced engineers from Maxon and four from Cortech decided to spin off.[17] They founded RTX as a turnkey solution development firm with the strategy to do R&D for other firms. RTX based their DECT design on chipsets from National Semiconductor and developed a very close cooperation with the US company. Later, National Semiconductor also acquired a part of RTX. National Semiconductor had previously worked with Dancall and needed the knowledge on the future development of wireless devices to design their chipsets and RTX vice versa. RTX grew from seven employees in 1994 to more than 200 in 2003. The firm has never had a spinoff and very few engineers have left RTX to join other firms.

During the last half 1990s a new bluetooth technology[18] became rooted in the cluster. RTX and Digianswer entered bluetooth very early and as a result Motorola acquired the latter in 1999. In early 2001 the UK-based Cambridge Silicon Radio (CSR) founded a parent spinoff in the region.[19] They hired a former Digianswer employee to start up the Aalborg department with the purpose of developing software for bluetooth devices.

During these years, several other experienced entrepreneurs decided to found spinoffs. Increasingly, other wireless technologies such as bluetooth became the main activities of these new firms and only one of them had activities directly in the area of mobile phones. This was ATL Research founded by engineers from Cetelco in 1996. While working at Cetelco they often got inquiries from other firms in the industry, who wanted to buy development aid for mobile phones. But since Cetelco was a R&D department of Hagenuk, it was not possible to follow the potential market within Cetelco. The breakthrough of ATL Research was when they presented the world's smallest dual band mobile phone after six months of development work in 1997. ATL cooperated with several chipset manufactures until Texas Instruments (TI) acquired the firm in 1999. When this happened, a group of engineers headed by Ole Madsen left ATL/TI to found a local affiliate of Condat (Germany). This firm was acquired by TI and merged with TI's other activities in Aalborg. This enabled the US company to develop an entire mobile phone by itself in Aalborg.

---

[16] In 2003, L.M. Ericsson downsized its division in Aalborg. Before that a group of engineers started Blip Systems, while another group was bought by SemCon Sweden, which located a division in Aalborg consisting of former Ericsson employees.

[17] All seven had previously worked for Dancall.

[18] Bluetooth is an industry standard for wireless data transmission over short distances between different types of devices.

[19] Other local firms also entered bluetooth (Penell and L.M. Ericsson). Also, a small group of relatively inexperienced engineers founded Bluetags in 2000 with the purpose of developing a bluetooth-based luggage tag.

At the global level, the mobile communications industry had high growth rates and mobile phone sales were skyrocketing in this period. The large multinational players in the industry were increasingly looking for new areas to base their activities in, in order to access local pools of development engineers. The Aalborg region had become very internationally visible within wireless communication and was an area where international firms could find the competencies they were searching for. As a result there were many parent spinoffs in the region from 1998 and onwards. Especially the big producers of chipsets and semiconductors entered the region. For example, Analog Devices (US) hired one of DC Development's engineers to create a department for systems solutions in USA. In 1997, he was sent back to start up R&D activities for Analog Devices in Aalborg to improve the research activities and cooperation with customers.[20]

3.1.4 The burst of the dot-com bubble and the uncertain future of the industry

The period from 1999-2002 was a turbulent period for the cluster since the growth was quite rapid, but the cluster was affected unfavourably by the crisis in the telecommunication sector from the summer of 2001 with stagnating sales. The crises led multinationals to change strategies of which some collected their R&D units in larger units (in their home country) and other reduced the R&D expenses. Consequently, many of the Aalborg divisions of multinationals were downsized tremendously, e.g. Nokia, Ericsson, Lucent etc.

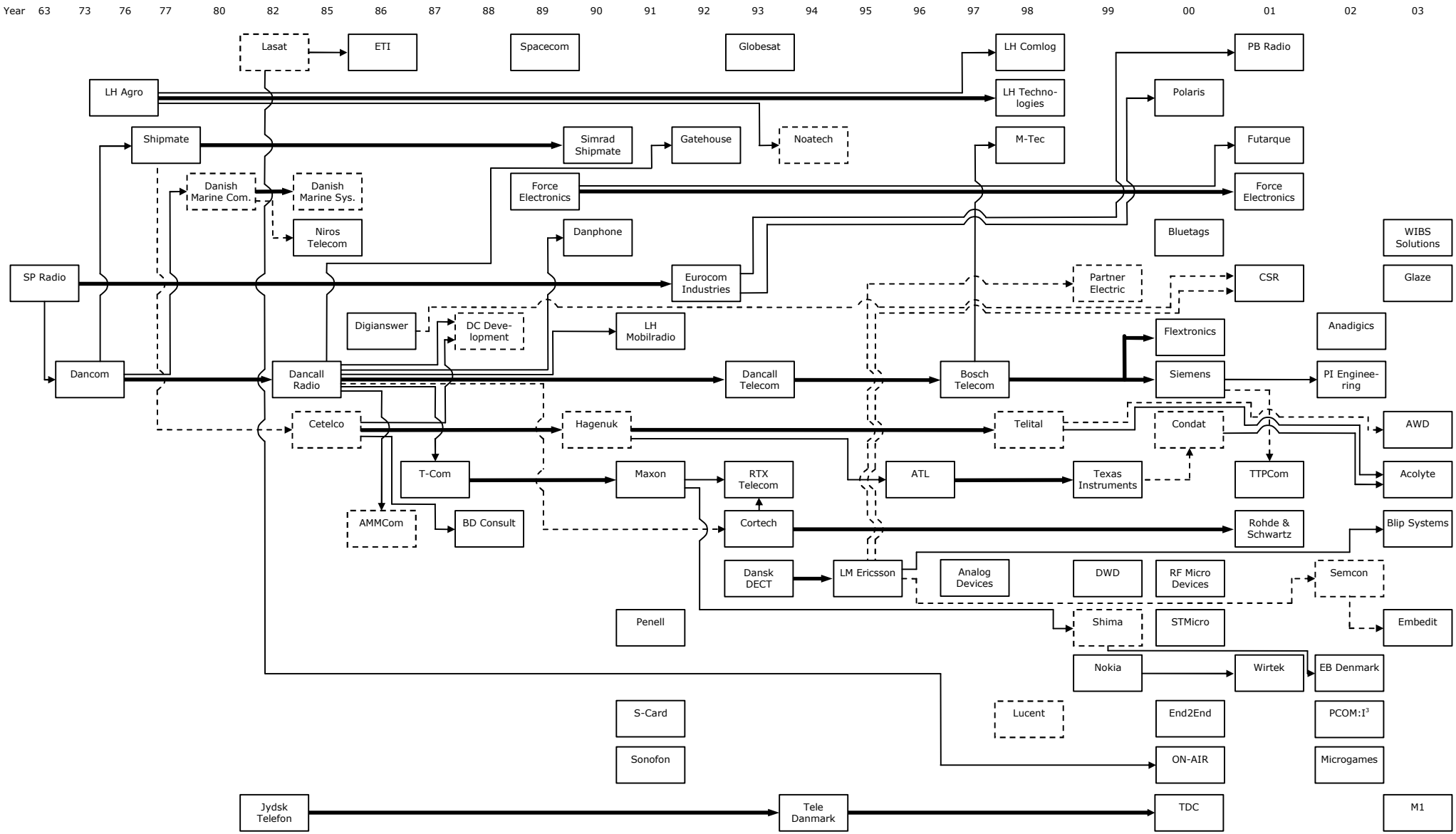
The crisis in the telecommunications sector in 1999 hit the service providers and the network infrastructure manufactures first, but in mid-2001 the terminal manufactures also had problems. The large multinational sacked engineers, but the smaller local firms hired them. Others founded their own firm, e.g. Wirtek, Futarque, EB Denmark and PI Engineering. The crisis kept going in 2002, where four firms exited. Three of which these went bankrupt, and one was acquired by the local Texas Instruments division. Despite these increases in exits, there was a still a growing number of firms in the cluster, because of higher entry rates.

3.2 The genealogical evolution

Figure 1 shows the genealogical evolution of the NorCOM firms. A bold full line between two firms represents a change in the original structure of the firm. This can either be a takeover by another firm or a reconstruction after financial troubles. Each arrow between firms indicates that one or more employees moved from the existing firm to found a new one – i.e. the entrepreneurial spinoffs (full arrow) or parent spinoffs (where founder or initial management have come from a local firm – broken arrow). Firms with a broken box have closed and exited. In general, further information on individual firm events are found in Table A.1 in the appendix.

[20] The NorCOM firms are not big buyers of components themselves, but they carry out R&D for many high volume manufacturers. In this phase, many very important strategic decisions are taken concerning choice of components, new trends, standards and norms, so it was increasingly important for chipset and semiconductor manufactures to have close connections to the R&D firms.

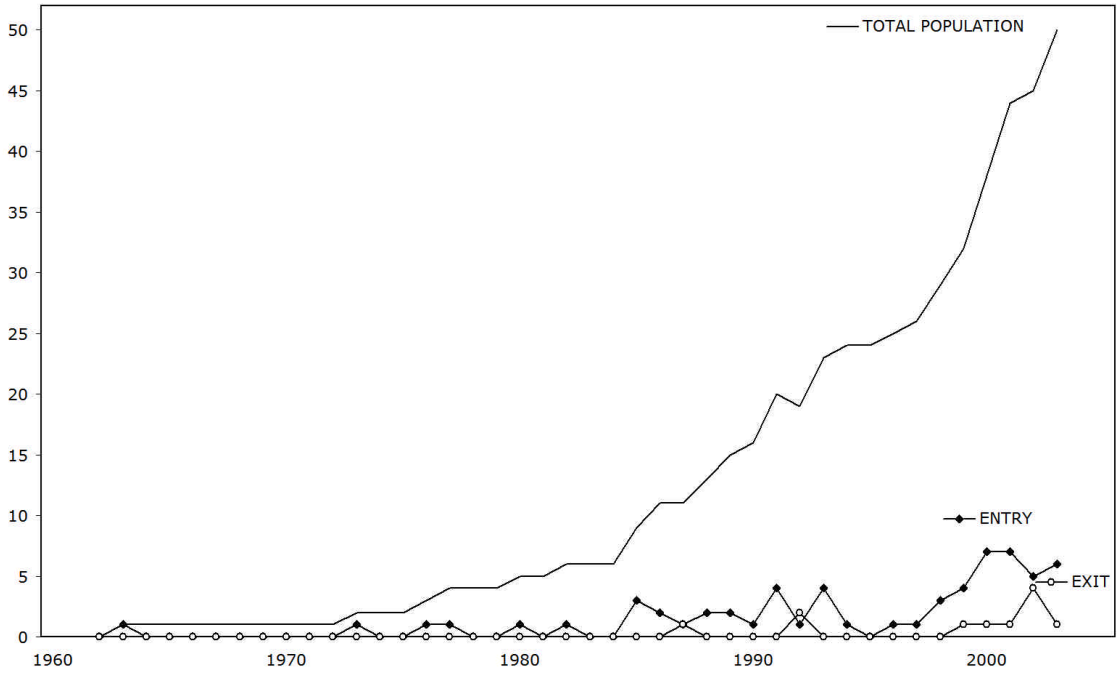
Figure 1: The Genealogy of the Wireless Communications cluster in North Denmark (NorCOM) - 1963-2003



3.3 Types of entry and their employment impact

The overall evolution of the population of firms in the cluster is shown in Figure 2. There has been a steady, and even increasing, growth in the number of entrants since the beginning.[21] Even after the turbulence caused by the burst of the dot com bubble there has been a substantial entry. As a result the number of firms is higher than 50.

Figure 2: Entry and exit of firms in NorCOM



The number exits has until now been remarkably low. The year 2002 has been the only year where the number of exits has been above two in one single year. Only 11 firms have exited over the history of the cluster. Several firms have, however, been rescued from exit on the verge of bankruptcy after being taken over by other firms, typically multinational corporations.

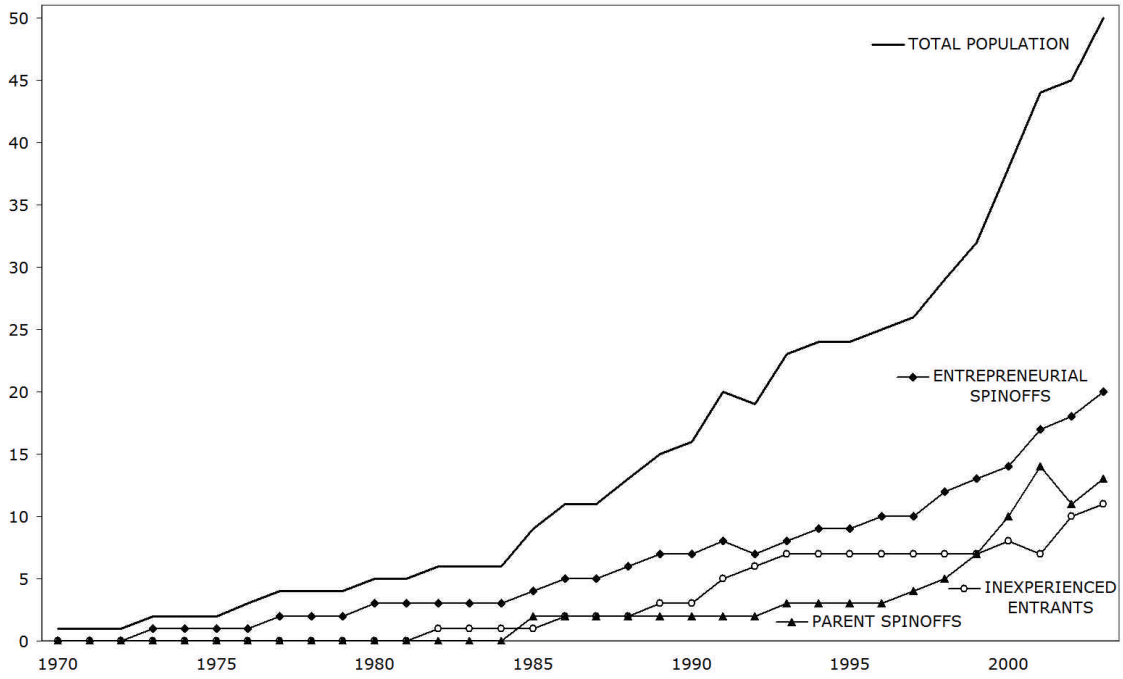
Three phases may visually be distinguished in Figure 2 in terms of different slopes of the total population curve. During 1973-84 the cluster grew from two to six firms, following the initial early success of the first parent, S.P. Radio. In the second phase 1984-95 the population of firms increased from six to 24 firms. In the third phase 1995-2003 the population increased from 24 to 51 firms.

In the process of constructing the genealogical tree in **Fejl! Henvisningskilde ikke fundet.**, detailed information on every firm being active in the cluster since the 1960s has also been collected concerning the type of entry,

[21] Given the small number problem of this study, warnings should be given concerning interpretation of concepts like 'change of growth rates' etc.

cf. Table 1. The evolution of the cumulative number of the three most important types of entrants is shown in Figure 3.

Figure 3: Entry and exit of new firms in NorCOM by main category



The diagram indicates that the entrepreneurial spinoff firms have represented a large share of the increase of the population. It has been the largest group of firms throughout the history of the cluster. The growth in the number of parent spinoffs since 1997 represents the increasing international visibility of the cluster. After the introduction of the GSM system, where local firms were at the front from the beginning, the international focus on North Jutland's wireless industry has increased the number of parent spinoffs from three in 1995 to 15 in 2001. Before 1995 there were mainly local or national based players behind the parent spinoffs. Later, it was foreign companies, such as L.M. Ericsson (SWE), Texas Instruments (US), Motorola (US), and National Semiconductors (US), which entered through acquisition of or investments in already established local firms. Multinationals such as Nokia (FIN), Lucent (US), Analog Devices (US), and Infineon (GER) located activities in the region through green field investments.

It should, however, be emphasized that the patterns shown in Figures 1 and 2 are based on counts of individual firms independent of there sizes. Table 3 indicates the general economic impact of the firms in terms of the top ten largest employment generators in 2003.

Table 2: Top ten employers in NorCOM.

No.	Name	Employees	Founded	Type[1]
1.	The old Dancall (Flextronics/Siemens)	1 520	1973	Entrepreneurial spinoff
2.	Sonofon	953	1991	Joint venture
3.	Eurocom Industries (SP Radio)	250	1948	Diversifier
4.	RTX Telecom	230	1993	Entrepreneurial spinoff
5.	Maxon Telecom (T-Com)	130	1987	Entrepreneurial spinoff
6.	Simrad Shipmate	120	1977	Entrepreneurial spinoff
7.	Texas Instruments (ATL + Condat)	105	1996	Entrepreneurial spinoff
8.	ETI	86	1985	Inexperienced startup
9.	Digianswer	83	1986	Inexperienced startup
10.	LH Technologies	80	1976	Diversifier
-	Remaining 40 firms (Avr. size: 15 empl.)	580	-	-
Total employent		**4 137**		

Employment data source: NorCOM Association (http://www.norcom.dk)
1. See Table 1.

The old Dancall firm is by far the largest employer due to the assembly plant now at Flextronics. The second largest is the mobile telephony operator Sonofon. Most of the remaining firms focus on development – and not manufacturing. Among the top ten firms, five firms are entrepreneurial spinoffs. This indicates that this type of entry can account for the majority of employees as well. To investigate this further, we have aggregated the employment figures for all the firms existing in 2003 for each type of entrant. This is shown in Table 3.

Table 3: Employment generation by different types of entry.

Type[1]	Employees	Number of Firms	Average size	Percentage
Diversifiers	330	2	165	8%
Parent-company activities:	1 270	17	75	31%
- Joint venture[2]	1 029	4	257	25%
- Parent spinoff	241	13	19	6%
De novo entrants:	2 537	31	135	61%
- Entrepreneurial spinoff	2 350	20	118	57%
- Inexperienced startup	187	11	17	5%
Total employment	**4 137**	**50**		**100%**

Employment data source: NorCOM Association (http://www.norcom.dk)
1. See Table 1 for further explanation.

The entrepreneurial spinoffs have generated by far the largest amount of jobs compared to the other types of entrants. In total, entrepreneurial spinoffs account for 56% of the total employment in the cluster. The second

largest group in terms of this is the joint ventures accounting for 25% of the employment. Inside this group, Sonofon represents 953 out of 1029 employees. Sonofon is a telecommunications service provider with a huge staff of supporters. It was located in Aalborg as a political decision to recognize the emergent cluster of firms in the industry. Firms founded by more inexperienced entrants do generally not grow as large as other firms. Part of the story is also that the restructuring of activities at the international level following the dot com crash in 2000 has been more extensive in the multinational companies. As a result the parent spinoffs connected to these firms have been downsized to a larger extent than other firms. However, local spinoff firms acquired by multinationals but managed by locally brought up entrepreneurs have suffered somehow less from this.

4 Discussion

The most powerful finding of this study is that entrepreneurial spinoffs account for the majority of the growth in the cluster. In terms of employment no other type of entry accounted for a growth in the same magnitude. We are able to confirm the hypothesis of the evolutionary account for spinoffs say that spinoffs will outperform other types of entrants.

Spinoffs are theoretically argued to be a source of path-breaking innovations and opening new submarkets (Anton and Yao, 1995; Wiggins, 1995). This is confirmed by our study. We find that spinoffs are often sources of increased variety. Especially in the later period, where the variety among the local industry firms increases as new spinoffs create businesses in niches and markets, which are new to the region and occasionally also to the entire industry. Incumbents have generally been more reluctant to enter emerging submarkets of the wireless industry. Most of them have concentrated on their core activities through time. Only one of the large incumbents (Dancall) has been able to succeed technologically in several technologies. Dancall started as a maritime communications spinoff with activities very close to the parents, but quickly moved into other submarkets such as closed onshore communication systems, cordless wired telephones, and later personal mobile telephony. This is an interesting example of a firm, which has been able to flexibly adjust to emerging markets not only as a young spinoff, as argued by Klepper (2001), but also in the later stages of the history of the firm. However, the firm has also been the most turbulent firm in the cluster. It has been financially troubled several times and reconstructed four times (three times with new owners/investors) on the verge of bankruptcy. The turbulent internal environment and uncertainty about the future has been a reason why Dancall has had the most spinoffs. Not only in the beginning, but throughout the history of the firm. This is a general feature of the cluster and confirms the arguments by Cooper (1985) and Brittain and Freeman (1986). Spinoffs are most likely to be a result of managerial problems or financial trouble giving uncertainty to the future of the incumbent firm.

Another reason that Dancall has many spinoffs could be that firms with broader product lines are argued to spawn more spinoffs, since they form inspirational learning environments for their employees (Franco and Filson, 2000; Romanelli and Schoonhoven, 2001; Klepper and Sleeper, 2002). The story about RTX illustrates that is not necessarily always the case. RTX was founded in 1993 as a spinoff of T-Com/Maxon and it is similar to Dancall in its profile in the sense that both are technologically broad with activities on a series of products. RTX has never had a spinoff and very few employees have left for other firms. The fundamental difference is that RTX provides a more secure economic environment and has a stable management. The firm makes a huge effort in optimizing the working conditions for its employees. Also, RTX is one of the few firms, which openly says that it does not have non-compete covenants in the contracts of any employee. The firm does not want to meet its new employees with distrust on the first day. The founders of RTX claim that they have created conditions

for their employees where there is time and support to pursue new innovations and ideas. Employees are encouraged to pursue their discoveries internally. As a long as this is the rule of the day, they argue that spinoffs will not occur. Consequently, RTX is constantly moving into new areas of business related to wireless technologies and recently also into biotechnology test equipment. In the case of Dancall, the financial troubles are very likely to have put constraints on the employees' possibilities to fulfill their ambitions by pursuing their discoveries. The firm was so focused on a few large projects, which limited the resources available for other minor projects. The magnitude of the large projects themselves was even too much to handle. This is the main reason behind the firm's continuing problems. Consequently, the employees may have been forced to spinoff in order to pursue their ideas.

The majority of the entrepreneurial spinoffs discussed in this study are a result of disagreements, management problems and general unhappiness with the way that the parent is governed. Founders report that as spinoffs age, it may seem that they were founded to take advantage of new opportunities developed at the parent organization. However, founders claim that this is most often not the reason for spinning off in the first place, but it is becomes a reality much later, when business plans change as the spinoff ages. Neither does spinoffs in this case study generally seem to be a result of missed opportunities as suggested by Tushman and Anderson (1986) and Romanelli and Schoonhoven (2001). There are only a few examples, where a spinoff has been founded as a reaction to missed market opportunities of a parent, e.g. the founding of T-Com/Maxon and ATL.

Founders argue that there is always a change in the mindset at a point in time, which changes the attitude of the employee from loyalty to disloyalty towards the employer. In that situation potential founders of new firms start to think about alternatives for working at the parent organization. This is very likely to be triggered by management inertia. It has been the most likely *reason* and *motive* behind founding a spinoff, but this does not rule out the fact that spinoffs are able to exploit the opportunities and competencies of the parent. As seen in disk drives (Franco and Filson, 2000) and lasers (Klepper and Sleeper, 2002), spinoffs have similarly relied on their 'employee learning' in the parent organization in their products. Consequently, they have often competed directly at least with some of the activities of the parent. An illustration of this is Dancom. It was founded because of disagreements with the management style and the personality of the parent's managing director/founder. Another example is RTX, which competed directly with their parents, Cortech and Maxon. The founders experiences enabled to them to compete directly with the parents on the exact same market, as argued by Cooper and Gimeno-Gascon (1992).

Another implication of this study is that local entrepreneurial spinoffs appear to have suffered less than the world wide industry after the burst of the dot com bubble. Parent spinoffs or divisions of large multination corporations in the region have been closed down or downsized to a much larger extent than other types of entrants. Former high profile entrants, such as L.M. Ericsson and Nokia, have virtually closed down all the operations in Aalborg. So it appears that given the amount of new entrants after the burst, the cluster has not been influenced to a significant extent. An interesting aspect is also that the employees, which have been sacked in the downsizing of Ericsson and Nokia, have started new firms themselves in groups. A group of former employees from Ericsson started their own firm financed by SemCon from Sweden. One year later Semcon Sweden pulled the plug on their division in Aalborg, but the employees continued as a division of the Copenhagen-based Embedit. Similarly, Nokia had a spinoff (Wirtek) during one of their downsizing operations. Both SemCon/Embedit and Wirtek now operate as suppliers to the multinational parents.

In a similar fashion, engineers have frequently changed employers in groups and project teams. When Shima and Telital had financial trouble in recent years, groups of ten to fifteen engineers left their employer together to join RTX and Texas Instruments, respectively. This enabled the project teams to stay together and continue their development activities. This type of inter-firm transfer of knowledge and capabilities has happened frequently throughout the history of the cluster. The movement of these coherent groups of people is likely to have immediate effects to the receiving firms. They are very likely to be well functioning and they have already built internal cooperation patterns and systems. This will enable them to have a relatively larger and more immediate impact compared with an establishment of the project groups from the bottom.

Since 1999, the business environment of the industry has been very turbulent. In this period, the number of exits has increased. However at the same time entry has also increased substantially. Although we are dealing with small numbers and only a few years is this case, this development seems to be typical for industrial clusters. In a study of the US footware industry, Sorenson and Audia (2000) found that both entry and exit increases as the local population of firms increases. The larger the population of firms, the larger is both entry and exit in the footware industry. This strongly suggests that traditional agglomeration economies could not account for the geographical distribution of the footware industry. It remains to be seen for the wireless communication industry, but there are several indications pointing in a similar direction as evidenced by the present case study. Instead Sorensen and Audia concluded that social networks are a valid explanation for the fact that entrepreneurs continue to found firms in concentrated areas, even when there does not appear to be any apparent benefits from such a location.

In the present case, founders confirm that social relationships are very important for founding a firm. A good example is again the founding of RTX. The six founders of the firm came from two different incumbents, Cortech and Maxon, and they knew each other from working together at Dancall in the past. After they had worked for the incumbents on the exact same technologies, they teamed up and founded RTX.

It is another characteristic of the cluster that venture capital (VC) has played a minor role historically. However, a few firms have been founded in more recent years backed by VCs, e.g. Bluetags and End-2-End. Even though the local science park (NOVI) was founded in the beginning of the 1990s, it has mainly acted as a supplier of office space to new firms and not directly as a VC. It has basically only supported Bluetags. This is probably the effect of a fairly underdeveloped VC-sector in Denmark, which are conservative towards these ventures.

There are several open questions concerning the spinoff process and the process of founding a firm, which are still unexplored in this context. Why do spinoffs occur? What triggers the separation process? What type of positions do future founders have in the parent organization? How are spinoffs financed? These are the important unanswered questions, which can give us a much better knowledge about the process of spinning off. Several studies have already confirmed that this exact type of entry is an important source of economic growth and variety and technological change in industries. The background of founders can potentially explain the growth patterns of units at all levels – from individual firms, entire industries as well as geographical regions and clusters.

5 Conclusion

A key component in the growth of the cluster has been the early performance of the first entrant, SP Radio. Both technologically and economically the firm was very successful and provided a good example for the following entrants. Through the 1970s and 1980s a series of new firms was founded as spinoffs, which became among the world leaders in NMT and GSM technologies. In the 1990s the activities of MNCs have added to the growth in number of firms. Often the large multinational players have founded subsidiaries as parent spinoffs by hiring or headhunting experienced local employees to start the new firms.

In this process of industrial transformation, competencies from the past became highly relevant for the wireless industry from maritime to personal mobile communications through the NMT and later the GSM standard. The success of the maritime companies fueled a series of confident entrepreneurial spinoffs often competing directly with the mother firm, SP Radio. The original and successful business design and organizational routines were inherited by the new organizations and then facilitated the overall basis for the formation of the cluster through rapid growth in the number of firms.

So far the dominating theories of economic geography and spatial agglomeration cannot sufficiently explain the emergence of clusters like the NorCOM case. The claims of the dominant theories about the initial factor conditions and overall regional attributes and institutional set-up as the explanations of the evolution of clusters in general do not appear to be satisfactory. In the NorCOM case, these factors cannot explain why this cluster of high-technology and research intensive firms all of a sudden grew up in a region, which had been lagging behind the remaining part of the country for decades - and dominated by farming, food processing, fishery and the process industries in mainly low growth manufacturing industries. Similarly the local market conditions did not support the formation of the cluster very well, since it has been oriented towards foreign markets from the very beginning with a high degree of exports.

The initial location of first firm in the cluster can at best be characterized as a chance event. The entrepreneur Simon Petersen returned to the region after studying at Aarhus Teknikum. It could basically have been anywhere else in the country.[22] Later, when the cluster had entered its initial growth phase, the local university was founded, but even in the years after that the firms had to rely on internal competence building and 'imported' employees from other Danish regions. In this early phase the 'quality of the parents' played a major role as an early seedbed for innovation and growth. In 1980s and 1990s, the university clearly had an effect through its growing supply of qualified labor and top-level basic research in the wireless technologies of the cluster.

The main finding of this paper is that spinoffs have been the central mechanism in the evolution of a high-tech cluster. Clusters have become a desirable phenomenon in the minds of many public policy makers. Most of the efforts to obtain this are directed more generally at different levels. However little attention is paid on the public policies on employee contracts, which can have a strong influence on how clusters develop through a spinoff process. The employee's future possibilities for founding a new firm can be very limited, if the employing organizations use non-compete covenants or clauses in their employment contracts. This type of adscription of employees will evidently limit the evolution of clusters and hinder employment growth through new firm formations.

[22] Two of Simon Petersen's classmates from Aarhus Teknikum, Peter Bang and Svend Olufsen, also went back to their home region (also a backward region) and founded the still existing consumer electronics manufacturer Bang & Olufsen.

6 References

Anton, J. J. and Yao, D. A. (1995) "Start-ups, Spin-offs, and Internal Projects." *Journal of Law, Economics, and Organizations*, *11*, pp. 362-78.

Arthur, W. B. (1990) "Silicon Valley Locational Clusters: When do Increasing Returns imply Monopoly?" *Mathematical Social Sciences*, *19*, pp. 235-51.

____. (1994) *Increasing Returns and Path Dependence in the Economy*. The University of Michigan Press.

Bankman, J. and Gilson, R. J. (1999) "Why Start-ups?" *Stanford Law Review*, *51*, pp. 289-308.

Bhide, A. (2000) *The Origin and Evolution of New Businesses*. New York: Oxford University Press.

Brittain, J. W. and Freeman, J. (1986) "Entrepreneurship in the semiconductor industry." *Mimeo*.

Carroll, G. R. (1984) "Organizational Ecology." *Annual Review of Sociology*, *10*, pp. 71-93.

Carroll, G. R.; Bigelow, L. S.; Seidel, M.-D. L. and Tsai, L. B. (1996) "The fates of *de novo* and *de alio* producers in the American automobile industry 1885-1981." *Strategic Management Journal*, *17*(Summer Special Issue), pp. 117-37.

Chatterjee, S. and Wernerfelt, B. (1991) "The link between resources and type of diversification: theory and evidence." *Strategic Management Journal*, *12*, pp. 33-48.

Christensen, C. M. (1993) "The Rigid Disk Drive Industry: a History of Commercial and Technological Turbulence." *Business History Review*, *Winter*, pp. 531-88.

Cooper, A. C. (1985) "The Role of Incubator Organizations in the Founding of Growth-oriented Firms." *Journal of Business Venturing*, *1*, pp. 75-86.

Cooper, A. C. and Gimeno-Gascon, F. J. (1992) "Entrepreneurs, Processes of Founding, and New-firm Performance." in D. L. Sexton and J. D. Kasarda (eds.) *The State of Art of Entrepreneurship.* Boston, MA: Pws-Kent.

Dahl, M. S. (2003) "Knowledge Diffusion through Labor Mobility: Engineers in Regional Clusters in Denmark." Aalborg: Department of Business Studies, Aalborg University, *Mimeo*, Web: http://www.msdc.dk.

Dahl, M. S. and Pedersen, C. Ø. R. (2003) "Informal networks in a regional cluster." Aalborg: Dept. of Business Studies, Aalborg University, *DRUID Working Paper Series*, No. 2003-01.

Dalum, B. (1995) "Local and Global Linkages: The Radiocommunications Cluster in Northern Denmark." *Journal of Industry Studies*, *2*(2), pp. 89-109.

Dalum, B.; Pedersen, C. Ø. R. and Villumsen, G. (2002) "Technological Life Cycles: Regional Clusters Facing Disruption." Aalborg: *DRUID Working Paper Series*, No. 2002-10.

Dosi, G. (1984) *Technical Change and Industrial Transformation: The Theory and an Application to the Semiconductor Industry*. London and Basingstoke: Macmillan.

Dyck, B. (1997) "Exploring Organizational Family Trees." *Journal of Management Inquiry*, *6*, pp. 222-33.

Engländer, O. (1926) "Kritisches and Positives zu einer algemeinen reinen Lehre vom Standort." *Zeitschrift für Volkswirtschaft und Sozialpolitik*, *Neue Folge 5*.

Fox, C. R. and Tversky, A. (1995) "Ambiguity Aversion and Comparative Ignorance." *Quarterly Journal of Economics*, *110*, pp. 585-603.

Franco, A. M. and Filson, D. (2000) "Knowledge Diffusion through Employee Mobility." Federal Reserve Bank of Minneapolis, *Research Department Staff Report*, No. 272.

Garvin, D. A. (1983) "Spin-offs and the New Firm Formation Process." *California Management Review*, (January), pp. 3-20.

Hannan, M. T. and Freeman, J. (1986) "Where do Organizational Forms come from?" *Sociological Forum*, *1*, pp. 50-57.

Helfat, C. E. and Lieberman, M. B. (2002) "The birth of capabilities: market entry and the importance of prehistory." *Industrial and Corporate Change*, *11*(4), pp. 725-60.

Henderson, R. A. and Clark, K. B. (1990) "Architectural Innovation: the Reconfiguration of Existing Systems and the Failure of Established Firms." *Administrative Science Quarterly*, *35*, pp. 9-30.

King, A. and Tucci, C. L. (2002) "Incumbent entry into new market niches: the role of experience and managerial choice in the creation of dynamic capabilities." *Management Science*, *48*(2), pp. 171-86.

Klepper, S. (2001) "Employee Startups in High Tech Industries." *Industrial and Corporate Change*, *10*, pp. 639-74.

____. (2002) "The Evolution of the U.S. Automobile Industry and Detroit as its Capital." Carnegie Mellon University, *Mimeo*.

____. (2003) "The Geography of Organizational Knowledge." Carnegie Mellon University, *Mimeo*.

Klepper, S. and Simons, K. (2000a) "Dominance by Birthright: Entry of Prior Radio Producers and Competitive Ramifications in the U.S. Television Receiver Industry." *Strategic Management Journal*, *21*, pp. 997-1016.

Klepper, S. and Simons, K. L. (2000b) "The Making of an Oligopoly: Firm Survival and Technological Change in the Evolution of the U.S. Tire Industry." *Journal of Political economy*, *109*(4), pp. 728-60.

Klepper, S. and Sleeper, S. (2002) "Entry by spinoffs." Pittsburgh, PA: Carnegie Mellon University, *Mimeo*.

Lorenzen, M. and Mahnke, V. (2002) "Global Strategy and the Acquisition of Local Knowledge: How MNCs Enter Regional Knowledge Clusters." Aalborg and Copenhagen: Danish Research Unit of Industrial Dynamics, *DRUID Working Paper Series*, No. 2002-8.

Mitchell, W. (1989) "Whether and when? Probability and timing of incumbent's entry into emerging industrial subfields." *Administrative Science Quarterly*, *34*(208-230).

____. (1991) "Dual clocks: entry order influences on incumbent and newcomer market share and survival when specialized assets retain their value." *Strategic Management Journal*, *12*(2), pp. 85-100.

Moore, G. and Davis, K. (2001) "Learning the Silicon Valley way." *Stanford Institute for Economic Policy Research*, No. 00-45.

Nelson, R. R. and Winter, S. (1982) *An Evolutionary Theory of Economic Change*. Cambridge, Massachusetts: Harvard University Press.

Palander, T. (1935) *Beiträge zur Standortstheorie*. Almqvist and Wicksell.

Phillips, D. J. (2002) "A Genealogical Approach to Organizational Life Changes: The Parent-Progeny Transfer among Silicon Valley Law Firms, 1946-1996." *Administrative Science Quarterly*, *47*, pp. 474-506.

Rajan, R. G. and Zingales, L. (2001) "The Firms as a Dedicated Hierachy: A Theory of the Origins and Growth of Firms." *Quarterly Journal of Economics*, *116*, pp. 805-51.

Roberts, E. B. (1991) *Entrepreneurs in High Technology*. New York: Oxford University Press.

Rogers, E. M. (1995) *Diffusion of Innovations*. New York: Free Press.

Romanelli, E. (1985) *Performance and Persistence of New Firm Strategies in Organizational Evolution: The Case of Minicomputers*. Columbia University, Ph.D. dissertation.

____. (1989) "Organizational Birth and Population Variety: A Community Perspective on Origins." in L. L. Cummings and B. M. Stew (eds.) *Research in Organizational Behavior*. Greenwich, CT: JAI Press, pp. 211-46.

Romanelli, E. and Schoonhoven, C. B. (2001) "The Local Origins of New Firms." in C. B. Schoonhoven and E. Romanelli (eds.) *The Entrepreneurship Dynamic: Origins of Entrepreneurship and The Evolution of Industries*. Stanford, California: Stanford University Press.

Schumpeter, J. A. (1934) *The Theory of Economic Development*. Cambridge (MA): Harvard University Press.

Shane, S. (2000) "Prior knowledge and the discovery of entrepreneurial activities." *Organization Science*, *11*, pp. 448-69.

Sorenson, O. (2003) "Social Networks and Industrial Geography." *Journal of Evolutionary Economics*, *forthcoming*.

Sorenson, O. and Audia, P. G. (2000) "The Social Structure of Entrepreneurial Activity: Geographic Concentration of Footware Production in the United States, 1940-1989." *American Journal of Sociology*, *106*(2), pp. 424-62.

Sorenson, O. and Stuart, T. E. (2001) "Syndication Networks and the Spatial Distribution of Venture Capital Financing." *American Journal of Sociology*, *106*, pp. 1546-88.

Thompson, P. (2002) "Surviving in ships: firm capabilities and survival in the US iron and steel shipbuilding industry, 1825-1914." Carnegie Mellon University, *Mimeo*.

Tushman, M. L. and Anderson, P. (1986) "Technological Discontinuities and Organizational Environments." *Administrative Science Quarterly*, *31*(3), pp. 439-65.

Von Hippel, E. (1987) "Cooperation Between Rivals: Informal Know-How Trading." *Research Policy*, *15*, pp. 285-305.

Weber, A. (1928) *Theory of the Location of Industries*. Chicago: Chicago University Press.

Wiggins, S. N. (1995) "Entrepreneurial Enterprises, Endogenous Ownership, and the Limits to Firm Size." *Economic Inquiry*, *33*, pp. 54-69.

Appendix

Table A.1: Details on each of the NorCOM firms

Name	Founded	Exit	Type[1]	Founder(s)	Events
SP Radio	1948	-	D	Simon Pedersen	- Diversified into maritime radio communications in 1963. - Renamed Eurocom Industries A/S in 1992 when acquired by SAIT-Radio Holland (BEL-NLD) and STN Atlas (GER)
Dancom	1973	-	S	P.E. Sørensen, Svend Hansen, Erik Sørensen (all SP Radio)	- Reconstructed in 1980 with Henrik Langkilde as manager. - It had 20-30 employees from the beginning and the Danish pension funds as major investors. - Renamed Dancall Radio in 1983 - Acquired by Amstrad (UK) in 1993 after bankruptcy and renamed Dancall Telecom - Acquired by Robert Bosch AG (GER) in 1997 and renamed Bosch Telecom A/S - Sold to Flextronics International (USA) (production division) and Siemens AG (GER) (R&D division) and split into two individual firms in 2000
LH Agro	1976	-	D	Per Larsen	- Renamed LH Technologies Denmark when acquired by InterAg Technology in 1998. Acquired by Spraying Systems Co. (Illinois, USA) in 2000
Shipmate	1977	-	S	Erik Sørensen and Erik Rauff (Dancom)	- Acquired by Simrad (NOR) in 1994 and renamed Simrad Shipmate.
Danish Marine Communication	1980	1987	S	Svend Hansen and Carl Eiler Carlsen (both Dancom).	- Reconstructed in 1985 as Danish Communication Systems (1985-87)
Lasat	1982	2001	I	Claus Christensen, Jens Christian Winther, Keld Nielsen (newly graduated engineers from Aalborg University)	- Acquired by Olicom A/S (DEN) in 1996 - Acquired by i-Data A/S (DEN) in 1999
ETI	1985	-	S	Mark Fitzhugh, Jesper Kaagaard (Lasat)	
Cetelco	1985	2002	P	Engineers from Shipmate	- Acquired by Hagenuk (GER) in 1990 - Acquired by Telital (ITA) in 1998, when Hagenuk went bankrupt and renamed Telital R&D Denmark A/S
Niros Telecommunications Development	1985	-	P	Gert Wolff and Preben Andersen (both Danish Marine Communication), Gorm Niros (Niros Telecommunication, Copenhagen) and Niros Telecommunication (DEN)	- Acquired by Hans Damm Research A/S (DEN) in 2003
Digianswer	1986	-	I	Ole Jensen	- Acquired by Motorola (US) in 1999
Ammcom	1986	1992	S	Engineer from Dancall	Reconstructed as RRI (1991-1992)
T-Com	1987	-	S	Jørgen Elbæk, Villy Andersen, Mogens Westeraa, Jørgen Bregnhøj, Niels Christian Gjerrild, Flemming Buus Pedersen and Sigmar Gudbjørnson (all Dancall)	- Acquired by C-Com Group Ltd. (UK) in 1990. - Owner was acquired by Maxon Telecom Co. (KOR) in 1991. - Renamed Maxon Telecom in 1994.
BD Consult	1988	-	S	Bent Dahl (Cetelco)	
DC Development	1988	1992	J	Dancall and Cetelco	- Closed in 1992 due to financial difficulties in parent companies.
Force Electronics	1989	-	I	Jan Skaug Sørensen	- Went into suspension of payments in 2001 and was split into two firms: Futarque and Force Electronics - Force Electronics was acquired by Satellitt Companiet (NOR)
Spacecom	1989	-	S	Peter Nielsen (Thrane & Thrane, Copenhagen (DEN), former SP Radio)	
Danphone	1990	-	J	Dancall and Hans Jørgen Jensen	- Hans Jørgen Jensen acquired a part of the Dancall 4000 project from Dancall (development of closed landmobile radio communication systems). Dancall continued to be an owner, but the employees bought a part of the company. Manager was Ole Jensen. - In 2000 manager Ole Jensen and technical director Jens Lucassen acquired all shares.
Penell	1991	-	I	Martin Jensen and Bjarne Flou	- Acquired by RTX Telecom in 2001. Continued as a separate entity.
Sonofon	1991	-	J	GN Store Nord (DEN) and Bell South (USA)	- In 2001 GN Store Nord sold their shares to Telenor (NOR), who owns 52,5% and Bell South owns the remaining 47,5%.
S-Card	1991	-	I	Steen Rasmussen	
LH Mobilradio	1991	-	S	Kurt Poulsen (Dancall Radio)	
Gatehouse	1992	-	I	Michael Bondo Andersen	
Cortech	1993	-	P	DeTeWe (GER)	- Founded when DeTeWe (GER) bought the cordless development department from Dancall - Acquired by Rohde & Schwarz GmbH & Co. KG (GER) in 2001 and renamed Rohde & Schwarz Technology Centre A/S

1. Types: D=Diversifier, J=Joint Venture, P=Parent Spinoff, S=Entrepreneurial Spinoff, and I=Inexperienced Startup (see Table 1).

Table A.1 (continued): Details on each of the NorCOM firms

Name	Founded	Exit	Type[1]	Founder(s)	Events
Dansk DECT Udvikling	1993	-	J	Nine firms	- Founded as a joint venture between the incumbent telecommunications service provider Tele Danmark A/S (by the subsidiaries Jydsk Telefon A/S and Telecom A/S), Bang & Olufsen Technology A/S, Dancall Radio A/S, Diax Telecommunications A/S, Kirk Telecom A/S, L.M.Ericsson A/S, Lasat Communications A/S, Partner Electric A/S and Radartronic A/S. The employees came from Mannesmann, Aalborg University, Bang & Olufsen, Diax Telecommunications and Tele Danmark. The managing director was Niels-Christian Gjerrild (Sonofon, former T-COM). - Acquired by L.M. Ericsson in 1995 and renamed L.M. Ericsson Danmark
RTX Telecom	1993	-	S	Jørgen Elbæk, Mogens Westeraa, Villy Andersen (all T-COM, and former Dancall), Jens Hansen, Jens Toftegaard Pedersen, and John Nissen Lund (all Cortech and former Dancall)	
Globesat	1993	-	I	Jens Gram, Karl Johan Damgaard, and Erik Christensen	
Noatech	1994	2000	S	Niels Ole Andersen (LH Agro)	
ATL Research	1996	-	S	Finn Andersen, Jan Thomsen and Jens Christian Lindof (all Cetelco)	- Acquired by Texas Instruments (US) in 1999 and renamed Texas Instruments Denmark
Analog Devices	1997	-	P	Esben Randers (Analog Devices (US), former DC Development, Cetelco) and Analog Devices (US)	
M-Tec	1998	-	S	Svend Mousten Hansen (Bosch)	- Jesper Fjeldsø Jensen buys a part of the company in 1998
LH Comlog	1998	-	S	Per Larsen (founder of LH Agro)	
Lucent	1998	1999	P	Lucent (US)	
Danish Wireless Design	1999	-	P	Infineon Technologies AG (GER) and Per Hartmann Christensen (Sony, München (GER), former DC Development and Dancall)	
Nokia	1999	-	P	Nokia (FIN) and Alan Jacobsen (Nokia Copenhagen)	
Shima Communication	1999	2002	S	Jørgen Bregnhøj and Peer Lohmann (both Maxon)	
Partner Electric	1999	2002	P	Jens Christian Winther (L.M. Ericsson, former Lasat) and Partner Electric (DEN)	- Reconstructed/renamed in 2001 as Partner Voxtream (2001-2002) - Reconstructed in 2003 as Partner Voxtream of 2003 in Vojens, Denmark
Polaris Electronics	2000	-	S	Sven Egelund Rasmussen and Klaus Torp (both SP Radio)	
Condat	2000	2002	P	Ole Madsen (ATL Research, former Dancall) and Condat AG (GER)	- Acquired by Texas Instruments (USA) in 2002 and merged with ATL Research (Texas Instruments Denmark)
RF Micro Devices Design Center Denmark	2000	-	P	RF Micro Devices (USA) and Niels Jørgen Jensen, managing director (former Dancall)	
STMicroelectronics	2000	-	P	STMicroelectronics (FRA/ITA)	
Bluetags	2000	-	I	Niels Klitsgaard and Carlos H. Østby	
End-2-End	2000	-	P	Niels Peter Langkilde and Deutche Bank (GER) Hewlett-Packard (US), and Cisco (US)	- Also named Pre-Tel Wireless.
Futarque Technologies	2001	-	S	Jacob Pedersen, Jesper Kaagaard (former ETI, Lasat), John Tveit and other former Force employees	- Futarque was founded as a R&D unit when Force went into suspension of payments. - Futarque was acquired by former employees, Novi A/S and Erhvervsinvest Nord
WirTek ApS	2001	-	S	Michael Aaen and others (all Nokia)	- When Nokia Mobile Phones decided to move the Aalborg research and development department to Copenhagen 13 employees decided to go their own way. WirTek ApS entered into a framework agreement with Nokia for the delivery of consultant services in the mobile browser technology area.
SemCon	2002	2003	P	SemCon (SWE)	- Founded by acquisition of parts of activities and employees in L.M. Ericsson. Head of department John Kristensen (former L.M. Ericsson)
Cambridge Silicon Radio (CSR)	2001	-	P	Michael Bak (Digianswer, former L.M. Ericsson), Carsten B. Andersen (L.M. Ericsson) and Cambridge Silicon Radio (CSR) (UK)	

1. Types: D=Diversifier, J=Joint Venture, P=Parent Spinoff, S=Entrepreneurial Spinoff, and I=Inexperienced Startup (see Table 1).

Table A.1 (continued): Details on each of the NorCOM firms

Name	Founded	Exit	Type[1]	Founder(s)	Events
TTPCom	2001	-	P	TTPCom (UK) with Morten Iversen, Brian Møller and Gäel Rosset (all Siemens Mobile Phones)	
ON-AIR	2000	-	S	Per Frost Jensen (Lasat, former Sonofon and Maxon) and IPM Management.	
P.B. Radio	2001	-	S	Peter Bak (Eurocom Industries)	- Acquired by Gatehouse in 2003
PI Engineering	2002	-	S	Carsten Pedersen (Siemens Mobile Phones)	
Anadigics	2002	-	P	Anadigics (US)	- Manager Rahim Torfi
EB Denmark	2002	-	S	Jan Lausten (Shima) and Hans K. Kofod (Siemens)	
PCOM:I[3]	2002	-	I	Jyoti Prasad	
MicroGames	2002	-	I	Henrik Hansen, Morten Jørgensen and Theis Olesen (newly graduated engineers from Aalborg University)	
Advanced Wireless Design	2003	-	P	10 former employees of Telital (Cetelco) and a Hong Kong based company	- The company was founded a few months after Telital went bankrupt. Torben Amtoft (Telital) is the managing director. He took 10 employees and all the production equipment with him.
Acolyte Denmark	2003	-	S	Michael Vistisen (Condat, former Telital), Søren Rønnest (Telital) and Claudio Freti	- The company was founded in 2002 in Switzerland, but in 2003 it started a division in Aalborg.
Blip Systems	2003	-	S	10 former L.M. Ericsson employees.	- The company was founded by 10 former employees of L.M. Ericsson Aalborg with Peter Knudsen as manager.
Embedit	2003	-	P	Embedit (DEN) and John Kristensen (Semcon)	
M1	2003	-	I	Mads Peter Veiby and Thomas Johan Have-mann	
Glaze	2003	-	P	Glaze System Tech (SWE)	
WIBS Solutions	2003	-	I	Rajeev R. Prasad	

1. Types: D=Diversifier, J=Joint Venture, P=Parent Spinoff, S=Entrepreneurial Spinoff, and I=Inexperienced Startup (see Table 1).