ETLA ELINKEINOELÄMÄN TUTKIMUSLAITOS
THE RESEARCH INSTITUTE OF THE FINNISH ECONOMY
Lönnrotinkatu 4 B 00120 Helsinki Finland Tel. 601322 Telefax 601753

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Pekka Ylä-Anttila - Raimo Lovio*

FLEXIBLE PRODUCTION, INDUSTRIAL NETWORKS AND COMPANY STRUCTURE - SOME SCANDINAVIAN EVIDENCE**

* Helsinki School of Economics.

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ABSRTRACT: Information tehnology based production has been a major force affecting industrial organizations and management practices. The traditional mass production paradigm and the organizational structures that evolved with it have been challenged by organizational innovations based on the ideas of flexibility and capacity to customize products. Technological, economic, social and organizational changes are interrelated. These changes seem to lead to a new phase in socio-economic development.

There is an interaction between technological and organizational change both inside and outside the business firm. Internal organizations are decentralized and part of the activities externalized to other firms in order to increase flexibility. Thus, externalization of activities is partly an outcome of adoption of flexible techniques and/or a strategy of flexible specialization. Just-in-time (JIT) inventory management systems and stressing quality and reliability in deliveries lead to close-knit and ongoing relations between suppliers and producers, i.e to an industrial organization consisting, to an increasing degree, of networks. The firms are not any more easily definable entities, rather they can be seen as 'a nexus of contracts', whose bounderies are blurred.

There is a growing amount of evidence that the new flexible technologies are more conducive to small than large firms and plants: economies of scale in production are of decreasing importance. However, scale economies are important, e.g., in R&D activities, financing and international operations. These tendencies lead to new modes of cooperative ventures and international alliances.

Empirical evidence from the Scandinavian countries on the changes in firm structure is well in line with the implications of the "flexibility paradigm". The average plant size seems to have been diminishing, especially in engineering where the adoption and diffusion of new techniques have been fastest. At the same time, however, the dominance of large corporations has been increasing in R&D and international operations. Evidence from some case studies supports the conclusion that firms have systematically been pursuing cooperative agreements to restore competitiveness in international marketing and R&D.

KEY WORDS: Flexible production, information technology, organizational change, industry structure, Scandinavian economies

Pekka Ylä-Anttila, ETLA - The Research Institute of the Finnish Economy and
Raimo Lovio, Helsinki School of Economics

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Flexible Production, Industrial Networks and Company Structure - Some Scandinavian Evidence

1. INTRODUCTION

During the past decade or so the analysis of organizations has become a major theme of economic research - both theoretical and empirical. The institutions that previously were taken as given in the standard economic analysis have become important objects of investigation. The modern firm is the central economic institution in this research. To understand economic growth or technical change institutions and institutional change have to be explicitely taken into analysis. Institutions (firms) that organize the production vary both over time and across industries and countries. In a dynamic economy there is continuous restructuring of business - old companies grow and change or die away, new companies are established and grow or are taken over by other firms. It is important to know, for example, how the changes in company structures and economic growth performance are interrelated, and why economic organizations emerge as they do and not in some other way.

Such questions as, where are the boundaries of the firm, how is firm size determined and what kind of inter-organizational relations exist, are more and more frequently asked. Information technology-based production has been seen as a major force affecting industrial organizations as well as management practices. The traditional mass production paradigm and the organizational structures that evolved with it have been challenged by organizational innovations based on the ideas of flexibility and capacity to customize products.

There is an interaction between technological and organizational change both inside and outside the firm. Internal organizations are decentralized and part of the activities are externalized to other firms in order to increase flexibility. Thus, externalization of activities is an outcome of adoption of flexible techniques and/or strategies of flexible specialization. Implimentation of just-in-time (JIT) inventory management systems and stressing quality and reliability in deliveries lead to close-knit and ongoing relations between material suppliers and producers, and between users and producers. In addition, R&D cooperation between firms, often rivals, is increasing because of high risks involved in large research projects. Hence, firms become more and more dependent on resources of other firms. The emerging industrial organization consists, to an increasing degree, of various kinds of networks.

The firm, as a part of a network, is not any more an easily definable entity; rather it can be seen as a 'nexus of contracts', whose boundaries are blurred (cf., for example, Aoki et al., 1990, Christensen et al., 1990 and Okko, 1989). That makes it a difficult task to study company and industry structures, since statistical data on contracts between firms and other determinants that define the 'real' bounderies of the firm are scarce.

The 1980s witnessed an acceleration in technological progress and major changes in organizing economic activities. Most industrial countries saw a surge of mergers and acquisitions; consequently the role of large, and often multinational, firms has been increasing. On the other hand, the number of new entries has been increasing and, in addition, there has been a clear tendency to decentralize activities among industrial companies as indicated above.

Thus, two opposite tendencies seem to have been affecting company structures and industrial organization. The purpose of this paper is 1) to elaborate upon the factors behind these tendencies, 2) to study especially the impacts of flexible production technologies on business organizations and inter-organizational relations and 3) to present some statistical evidence on recent changes in Scandinavian plant and company structures.

2. A NEW INDUSTRIAL REVOLUTION UNDER WAY: FROM MASS PRODUCTION TO FLEXIBLE MULTIPRODUCT FIRMS

21. The Debate of the 1980s

The main outcomes of the debate of the 1980s on the nature of technical change can be summarized as follows: Technological, economic and social changes are interrelated; most industrialized economies are experiencing a period of a deep technological transformation - traditional mass production systems (or Fordist models) are replaced by new, information technology driven models based on ideas of flexibility; the transformation is pervasive and generic, which implies that technical change induces social changes - but, on the other hand, technical progress is conditioned by transformations in social institutions (for an extensive discussion, see, e.g., OECD, 1989 and Ollus et al., 1990).

There is a widespread and growing consensus about the general trends outlined above. But that is where the unanimity usually ends. As far as the reasons for the changes and, for example, the coverage of the implications across industries are concerned, the consensus is far from complete (cf. Edquist & Glimell, 1989). It is not the purpose of this paper to take sides, but there is no doubt that the development of various technologies based on microelectronics has been a major driving force behind the changes. Certainly, the market-driven transformation is part of the story too: one has only to keep in mind that during the recession of the mid-1970s the most Fordist industries (with long production runs, rigid automation and Tayloristic division of labor) were most severely hit by the production and productivity slowdowns - speedy response to demand fluctuations and to changes in demand structures proved to be a competitive advantage. In any case, flexible technologies are in most cases a prerequisite for flexible responses to changes in market demand.

All in all, the manufacturing industry is undergoing a revolutionary phase induced by structural changes in market conditions and radical changes in production technologies. The basic features of the traditional 'Fordist model' and the 'New model' are compared in Table 1.

Table 1. FROM FORDISM TO A NEW MODEL: A SYNOPTIC PRESENTATION

FORDIST PRINCIPLES	THE CHALLENGES OF THE 70's AND 80's	THE PRINCIPLES OF A NEW MODEL
F1 : Rationalisation of labour is the main target, mechanisation is the means	C1 : Under-utilisation of equipment, large inventories of work in process	P1 : Global optimisation of the whole productive flows
F2 : First design and then manufacture and organize work process	C2 : Lags and large costs in passing from innovation to effective production	P2 : Tentative full integration of research, development and production
F3 : Indirect and mediated links with consumers via marketing studies and strategies	C3 : Loosing touch with choosy consumers, failures in launching new products	P3 : Close and long lasting ties between producers and users, capture learning by using effects
F4 : Low cost for standardised products is the first objective, quality the second one	C4 : Ex-post quality controls cannot prevent a rising defect rate, consumers more selective about quality	P4 : High quality at reasonable costs, via a zero defect objective at each stage of the production process
F5 : Mass production for stable and rising demands, batch production for unstable demands	C5 : Even mass consumers demand become uncertain : the fordist production process appears as rigid	P5 : Insert the market demand into the production process, in order to get fast responses
F6 : Centralisation of most decisions about production in a special division of a large firm	C6 : Sluggish and unadequate reaction of head quarters to global and local shocks	P6 : Decentralization as far as possible of production decisions within smaller and less hierarchical units
F7 : Vertical integration, mitigated by circles of subcontractors	C7 : Given radical innovations, even large firms can no more master the whole techniques needed for their core business	P7 : Net working (and joint ventures), as a method for reaping both specialisation and coordination gains
F8 : Facing cyclical demand, subcontractors are used as stabilizing device, in order to preserve large firms' employment	C8 : During the 70's, bankrupcies and/or loss of competence of subcontractors, now confronted with international competition	P8 : Long run and cooperative subcontracting as far as possible, in order to promote joint technical innovations
F9 : Divide and specialize at most productive tasks, main source of productivity increases	C9 : Excessive labour division might turn counterproductive : rising control and monitoring costs ; built-in rigidity	P9 : To recompose production, maintenance, quality control and some management tasks might be more efficient, technically and economically
F10: Minimize the required general education and on the job training of productive tasks, according to the BABBAGE's and TAYLOR's principles	C10: New techical opportunities (IT), more competition and uncertain demands challenge most of the previous very specialized tasks	P10: A new alliance between a minimal general education and effective on the job training, in order to maximize individual and collective competence
F11: Hierarchical control and purely financial incentives to manufacture an implicit consent to poor job content	C11: Young generations,better educated and with different expectations, reject authoritarian management styles. Too much control becomes counterproductive	P11: Human ressources policies have to spur workers'competence and commitment and work out positive support for firms strategy
F12: Adversarial industrial relations converge towards wage demands ; collective agreement codify a provisional armistice	C12: Firms employment might be hurt by the lack of cooperation and an exclusive concern for wage A contrario, concession bargaining does not necessarily provide any advantage for wage-earners	P12: An explicit and long term compromise between managers and wage earners is needed to reap a general support to this model : commitment versus good working conditions and/or job tenures and/or a fair sharing of modernisation dividends

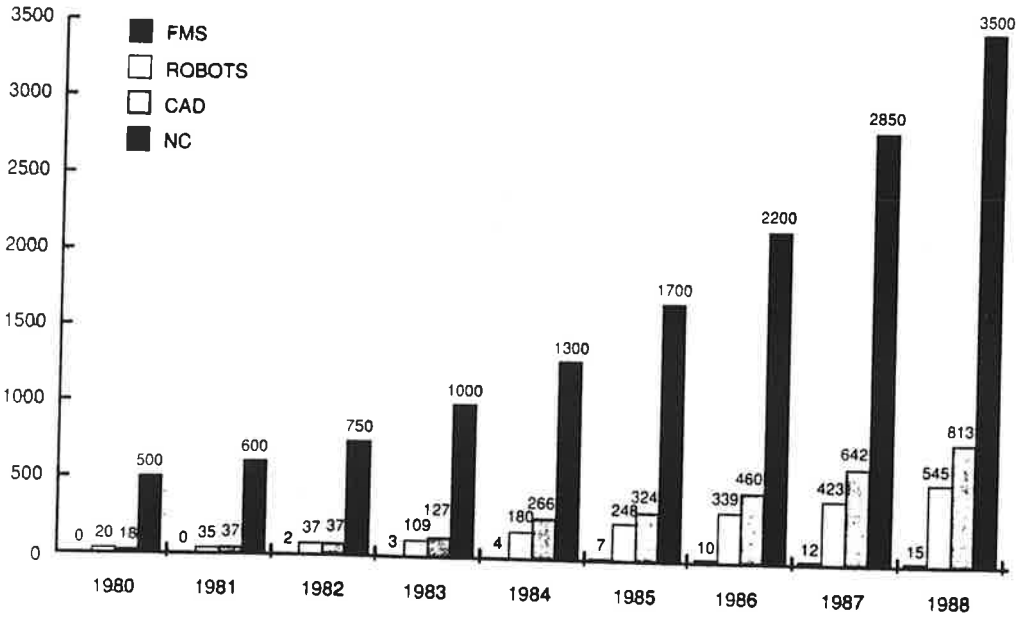
Source: Boyer (1989).

The implications of the new model, of course, vary across sectors and industries - one only has to think of heavy process industries on the one hand, and engineering, on the other hand, in the light of Table 1. There are many industries where the Fordist model will doubtlessly remain valid one for a long time come.

22. Flexible production technologies and organizational change

The break-through of the flexible production systems took place in the early 1980s and the applications are, so far, mainly in the engineering industry. The total number of integrated FMSs (flexible manufacturing systems) is still quite small - around 2500 worldwide - but the growth rate is impressive. The world markets for various CIM components (CAD systems, robots, CNC-machines, etc.) have been growing at an annual rate of 15-20 % (see Ollus et al., 1990). As an example the diffusion of CIM technologies in Finland is presented in Figure 1.

Figure 1. Diffusion of CIM components in Finnish manufacturing



Source: Ollus et al. (1990).

But maybe more important than the rapid diffusion of the flexible technologies is the adoption of associated organizational innovations in management of materials and the work-force. It has been estimated that about half of the efficiency gains to be achieved by introducing FM systems can be accounted for changes in organization and manage-

ment practices (see Vuorinen, 1987 and the references therein). Sectoral case studies show that in many industries where technical flexibilities can be introduced only to a limited extent, i.e. technological opportunities are very restricted, the flexible model has been adopted. Organizational changes play a relatively more important role in these cases (see Ollus et al., 1990 and Vuori & Ylä-Anttila, 1988).

It has been shown in several studies that **all** major technical innovations have led to some corresponding organizational changes in firms adopting them. It has even been argued that technology is the main determinant of the firm's organization and management structure (see, e.g., Freeman, 1989 and references therein).

In the case of firms adopting flexible manufacturing technologies the interaction of technology and organizational change is bound to be of great importance. The key features of the new technologies are integration of various activities and increased flexibility, which are supposed to yield enormous gains in efficiency and reduce costs. In reaping these benefits the mismatch between technology and organization has been argued to be a major problem (cf. Freeman, 1989 and Transnational Corporations..., 1989).

Flexible manufacturing involves production in small batches, reduction in work-in-process and finished goods inventories, ability to adapt to changes in customer specifications and consequent rapid changes in production lines, as well as short lead and delivery times. To achieve the required organizational flexibility a greater decentralization of decision making is needed. Speeding up all activities of the firm is the key factor in creating a competitive edge.

The interaction of technological and organizational change is visible not only inside the firm but it changes also the inter-organizational relations. Both the internal and external interaction is dealt with in more detail below.

3. FLEXIBLE FIRMS AND NETWORKS - NEW MODES OF ORGANIZATION

31. The flexible firm - what is it ?

What does then the adoption of the flexible model mean in terms of organizing various activities of the firm ? What kind of implications does it have for industry structures ? Does the adoption of the flexible model imply that big firms grow bigger or is the flexible model more conducive to small firms ?

Previously flexibility (if touched upon at all) was defined in the standard economic literature as an ability to accommodate greater (short-run) variations in output, i.e. it was associated with the characteristics of production technology that makes the average total (U-shaped) cost curve flat and the marginal costs to grow slowly. In the light of

the discussion above a much broader definition is needed. Flexibility has as much a long-run dimension as a short-run aspect - from the managment and business policy point of view it is not only a tactical issue, but to an increasing degree an important element in business strategy. In addition, it has a static and a dynamic dimension - the former meaning the ablity to utilize economies of scope, and the latter the ability to flexibly change production capacity (in the medium term) and the "size" of the entire company (in the long run). (For a discussion of various dimensions of firm flexibility, see Carlsson, 1989 and Ollus et al., 1990).

Like in the context of socio-economic change the impacts of new flexible technologies are seen as pervasive and generic also in the case of emerging firms. The move towards a CIM (computer integrated manufacturing) based factory (or company) is not a matter of partial change, or more precisely, a matter of adopting only some elements of flexible technologies. Rather, especially in the management literature and in empirical business studies it has been argued that the ideas of flexibility have to cover the whole range of a firm's activities. Thus, in the modern firm utilizing advanced technologies there seems to be a cluster of characteristics reflecting the adoption of the flexibility strategy. These characteristics are seen in design, production, inventory control, marketing and management practicies alike. The management can facilitate greater flexibility of activities by using information technology as a coordinating and integrating tool.

Milgrom and Roberts (1990) show that clustering of "flexibility characteristics" is consistent with optimizing behavior of the firm. It is a result of adoption of the kind of comprehensive business strategy described above - the strategy which exploits various complementarities inherent in activities organized in a flexible manner. These complementarities make it profitable for the firm that adopts some flexibilities to adopt more (see Milgrom and Roberts, 1990). The predictions of the (MR) optimizing model are well in line with the empirical observations and technology based theories referred to in the previous sections.

If the clustering of certain characteristics and utilizing complementarities in various activities of the firm is the central property of the flexible firm, would it mean that such firms tend to grow bigger and bigger ? Not necessarily - as a matter of fact, the opposite might be more likely. Exploiting the complementarities in flexibly organized activities does not have to take place inside the firm, it may as well - or even more likely - be organized through inter-organizational arrangements. The reason is simply that these arrangements allow the firm to reap both specialization and coordination gains (cf. Table 1 and Milgrom and Roberts, 1990). This brings us to the concept of networks. Networks consist of inter-firm transactions not governed by markets.

32. Firms and networks

Just-in-time inventory management systems and stressing quality and reliability in deliveries lead inevitably to close-knit and ongoing relations between material suppliers and producers, and between users and producers. Vertical integration is to an increasing

degree replaced by contracts with independent suppliers, still keeping the coordination function inside the firm. Supplier-manufacturer relations emerging in this way differ clearly from the traditional subcontracting of the mass production model. In the flexible model the price is not the only (or main) factor determining the choice of a supplier. It is more a question of mutual reliance and benefits stemming from, e.g., complementarities in technology or an incentive to share risks. Manufacturing companies may also decentralize activities horizontally, in order to exploit specialization gains. They may concentrate on engineering, design or assembly and contract part of the activities out. Contracting-out of supporting services has been one of the major trends in all industral countries during the last 10-15 years. Hence, firms become more and more dependent on resources of other firms. The emerging industrial organization consists of various kinds of networks. The modern firm is a nexus of both internal and external contracts (cf. Reve, 1990).

From the methodological point of view the firms are not seen only as parts of the whole that function from their inherent qualities. In addition to this, a firm's position and function in the system (network) is important (cf. Beije, 1989).

Transaction cost theory (Williamson, 1975 and 1985) is most widely used to theoretically justify the existence of networks (for alternative theoretical frame works, see for example, Christensen et al., 1990). Transaction costs arise due to bounded rationality of actors, opportunistic behavior, small numbers in bargaining, information impactedness (assymmetric distribution of information among the exchanging partners) and asset specificity.

The transaction costs increase (transactions are difficult to perform) when asset specificity is high, uncertainty (on the definition and performance of the transaction) is high and transactions are infrequent. The central idea of the transaction cost theory is that the properties of the transaction cost define the governance structure: in the case of high asset specificity and uncertainty, coupled with infrequency, the transactions are internalized to be performed inside the firm (hierarchy). In the opposite case the transactions are governed by markets. The firm is constantly considering the make or buy decision. Adoption of the flexibility model seems to suggest that a growing part of firms' transactions fall to be performed between markets and hierarchies, i.e. by bilateral contracts. Standardized products and inputs are typically dealt with in classical markets, but the transactions regarding customized products or semi-finished goods are performed in terms of contracts, the transactions are relatively infrequent (given the tailored products) and asset specificity of medium level or mixed.

The contract is among the central notions of transaction cost theory. It is not defined only in the traditional sense as a detailed agreement between the parties. It covers also implicit contracting and looser contracts where trust plays an important role (see Williamson, 1985 and Reve, 1990).

An important technology-driven tendency in changing industrial organization is the growing R&D cooperation between rivals: cooperation is seen as a source of competitive strength in industries where technical progress contains high risks.

Many technical research and development projects are simply too huge to be carried out by a single firm.

All this seems to imply that the boundaries of the modern firm are becoming blurred: various types of contracts and cross-wise ownership make it difficult to define the 'real' boundaries. The nature of the contracts may vary from clearly defined contracts to loose agreements based on mutual trust or they can be strategic alliances which collapse whenever the position of one of the parties changes. The traditional statistics do not capture very much of the network type of industrial organisation.

What then could be said about the firm structure using traditional statistics and concepts? The average plant size should be diminishing, since the economies of scale are of decreasing importance in flexible production and specialization should lead to externalization of activities and/or selling off parts of firms or plants. Restructuring of business should be seen as a renewal of the outstanding stock of companies (as growing numbers of entries and exits), although many of the relevant features of restructuring remain uncovered in the traditional statistics. Scale economies seem to be of increasing importance in R&D. Hence it is expected that R&D is carried out to an increasing degree in larger units. Fragmentation of markets and firms' strategy of concentrating on narrow segments is leading to growing internationalization of business, which usually means larger units. That constitutes a counter-tendency to decreasing firm size stemming from adoption of the flexible model in manufacturing.

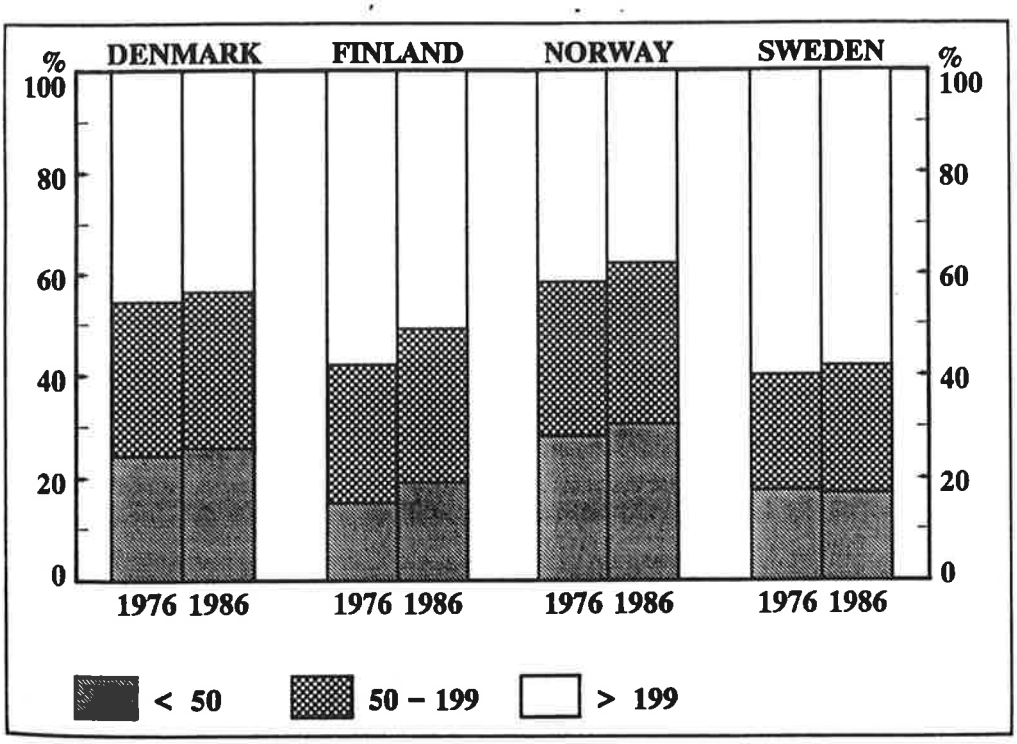
In the next section we look at statistical data on changes in plant and firm size in the Scandinavian countries (section 41). We also give an illustration of firms in networks by presenting a company case from the electronics industry (section 42).

4. COMPANY SIZE AND INDUSTRY STRUCTURE IN A SCANDINAVIAN PERSPECTIVE

41. Company structures in transition

Company structures in the Nordic manufacturing industries have undergone major changes during the past decade. All the countries (Denmark, Finland, Norway and Sweden) have seen a merger wave and a consequent strengthening role of large industrial firms in the economies. On the other hand, the number of new entries has been growing - contrary to what happened in the early 1970s. New entries in Finnish manufacturing have been relatively much higher than in the other three countries: The number of new business starts around the mid-1980s was in Finland about three times higher than in the late 1970s. The corresponding figures for the other Nordic countries were below this, showing, however, a clear growing trend (see Firm Dynamics..., 1990 and also Figure 2).

Figure 2. Number of persons engaged in manufacturing by size of establishment, % of total employment, 1976 and 1986.



Source: Yearbook of Nordic Statistics

Figure 2 displays the inter-country differences in existing plant structures and changes over a ten-year period. In Swedish manufacturing the "large" establishments (with more than 200 employees) have a clearly more important role than in the other Nordic countries. Norway is at the other end of the spectrum: about one third of the total manufacturing employment is in small business (i.e. in establishments employing fewer than 50 persons). In Finland the changes have been greatest among the four - the employment share of the small business group was the lowest in the mid-1970s, but has clearly increased since then as a consequence of the new entries and/or decentralization of activities of existing firms.

The differences as well as changes in the role of large manufacturing companies across the Nordic economies are presented in Table 2. The dominance of large corporations is by far the clearest in Sweden and also the changes in this respect have been most visible (see ETLA et al., 1990).

The increase in the dominance of large corporations in the industrial structure - as presented in the Table 2 - is mainly due to the growth of international operations. That is evident from the Swedish data in the table, but the same applies to Finland (see Ripatti & Vartia & Ylä-Anttila, 1988) and to a lesser degree to Denmark and Norway as well (see ETLA et al. 1990). The growth of large companies has taken place mainly through mergers and acquisitions.

Table 2. Share of employment of the largest manufacturing companies in total manufacturing employment, 1974/75 and 1986/87, %

	Denmark		Finland		Norway		Sweden	
	1974	1987	1975	1987	1974	1987	1974	1986
10 largest	11.6	15.8	22.3	34.3 (28.6)	16.9	31.9 (23.3)	41.0 (24.2)	58.6 (32.2)
20 largest	16.7	22.7	33.6	52.9 (43.1)	22.9	39.9 (30.1)	52.3 (33.1)	76.8 (39.7)
30 largest	20.8	27.2	40.1	61.5 (50.7)	27.7	44.4 (33.7)	59.3 (38.8)	85.3 (43.5)

Source: Firm Dynamics... 1990. The figures in parenthesis indicate the share of the largest companies' domestic employment in total manufacturing employment.

In the same same way as big companies have strengthned their positions in international operations they have increased their role in R&D activities. That is seen from Table 3.

Table 3. Share of R&D expenditure of largest manufacturing companies in total domestic R&D spending of manufacturing industry, %

	FINLAND		NORWAY		SWEDEN	
	1986	1988	1985	1987	1986	1988
10 Largest	59.1	73.3	70.0	80.2	80.4	..
20 Largest	..	93.6	76.1	88.8	87.5	..

Source: Firm Dynamics...1990

In light of the merger wave it is a bit surprising to observe that the average plant and company sizes have not been growing - Sweden being the only exception (cf. Carlsson, 1988). Table 4 displays the course of development in average plant size in the Nordic manufacturing and engineering industries.

Table 4. Average plant size in manufacturing (SIC 3) and in engineering (SIC 38) in the Nordic countries, number of persons engaged

	Denmark		Finland		Norway		Sweden	
	Manuf.	Engin.	Manuf.	Engin.	Manuf.	Engin.	Manuf.	Engin.
1976	58	75	83	109	44	57	78	95
1986	57	64	75	80	45	53	85	99

Source: Firm Dynamics... 1990

The same phenomenon - declining average plant size - is visible in most other industrial economies, too (see Carlsson, 1988). Especially the declining trend is observed in the engineering industries, where the adoption and diffusion of flexible technologies has been fastest. This is confirmed also by the Finnish data in Appendix 1, which show that in all the branches of engineering the decrease in the average plant size over the period 1976 to 1987 has been faster than the corresponding change in total manufacturing. There is a growing amount of evidence that flexible technologies are probably more conducive to smaller rather than larger firms (see, e.g. Diwan, 1989). The minimum efficient scale is decreasing especially in engineering where the batch size is becoming smaller and product cycles shorter.

There are two mechanisms through which the new technologies influence the size distribution. One is vertical (and to a lesser degree also horizontal) disintegration as a result of the adoption of a strategy of flexible specialization involving disinvestment and decentralization of activities. The second mechanism is the growing number of new business starts based on flexible automation with lower (unskilled) labor intensities than the traditional mass production.

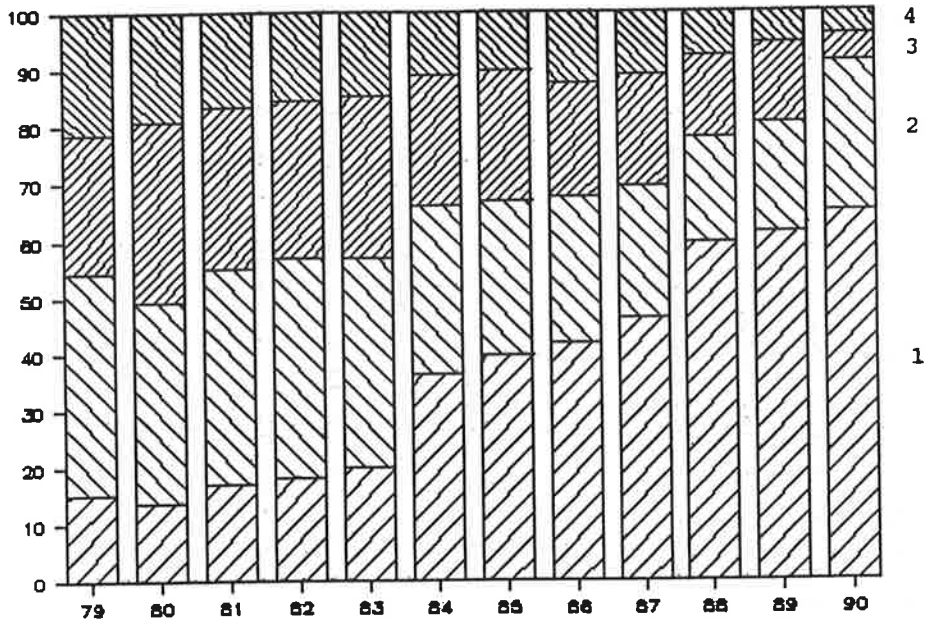
42. Company case: Nokia Group

Nokia Group is the largest industrial group in Finland in terms of the number of employees, and the second largest in terms of net sales. During the 1980s, the group went through a very rapid structural and organizational change. Major trends of the group have been rather similar to trends of other large industrial groups in Finland, although the changes in Nokia Group have been unusually dramatic.

In the beginning of the 1980s, the group included five business groups (cable and machinery, paper, rubber, floorings and electronics). The electronics division accounted for 15 % of net sales. In 1990 the group's strucutre is based on a division into six business groups, four of which are engaged in the electronics industry (Nokia Consumer Electronics, Nokia Data, Nokia Mobile Phones and Nokia Telecommunications). The other two are Cables and Machinery, and Basic Industries. Four electronics groups account for 65 % of net sales of the group (figure 3). Nokia Group is the second largest firm in the electronics industry in the Nordic countries (after LM Ericsson) and a rather big player in the production of colour TV sets, mobile phones and information systems in the European market. During the same time period the personnel of the group has increased from 20 000 to 37 000 employees.

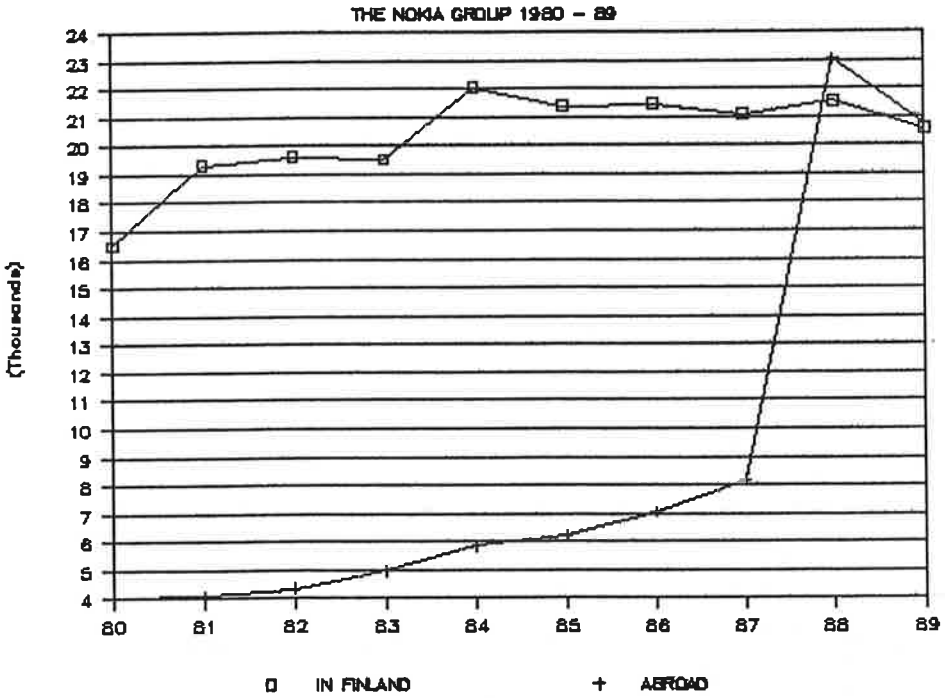
The growth and structural change of Nokia Group has taken place mainly through mergers and acquisitions. On the one hand, the group has acquired other firms in the electronics industry (Telenokia, Salora and SLO in Finland, Luxor and the computer business of LM Ericsson in Sweden, Oceanic in France, SEL in FRG ...) and in cable and machinery industries. On the other hand, the group has sold its old units in basic industries. Minor part of the growth has been in-house growth of old business activities of the group.

Figure 3. Net Sales by Business Group



1. Electronics
2. Cable and Machinery
3. Paper, Power, Chemicals
4. Rubber, Floorings

Figure 4. Personnel in Finland and Abroad



Secondly, the major acquisitions have been those of foreign firms, although Nokia has also strengthened its position in the electronics industry in Finland. Due to this fact the group's personnel in Finland is almost the same as it was in the beginning of the 1980s, but the personnel outside Finland has climbed almost fivefold. In 1980 Nokia Group employed16 500 persons in Finland and 4 000 abroad. In 1990 the group's personnel is about 20 000 persons both in Finland and abroad (figure 4).

The nature of Nokia Group's growth process seems to verify the argument that in the 1990s economies of scale lie mainly in abilities to organize international operations (production and R&D co-operation, international marketing and financial operations), and not any more in economies of scale of production processes as such.

This conclusion is supported by the development of Nokia Group's organization during the 1980s. One striking feature of this development has been the decreasing share of the parent corporation Nokia in the net sales of the whole group. The parent company accounted for 70 % of net sales in 1980, 56 % in 1985, but in 1990 only 5 %.

This has taken place because most of the recently acquired firms have continued their activity as legally (and in many cases also actually!) separate corporate entities and because the parent company has spun off many old business operations into independent companies. Due to this arrangement the number of Nokia group companies has rapidly increased: the 1980 annual report mentioned 33 group companies (of which 15 were abroad), the 1985 report 60 companies (42) and the 1989 report 130 (104).

The next step in organizational process is expressed in the review of 1989 by the board directors in a following way: "Nokia is in the process of altering its corporate structure to create a pattern of sub-groups, each operating in a specific segment of industry and based on independent companies. This arrangement will provide a clearer basis for the strategic development of the group as a whole." In the near future there will be five legally independent sub-groups, four electronics sub-groups and one cable and machinery sub-group.

Because of the processes of internationalization and decentralization, Nokia Group in the 1990s is no longer a national hierarchical corporation but an international coordinated network of independent sub-groups and sub-sub-companies. There is no longer one large corporation but many large, medium and small-sized companies belonging to the same group. Firm size has increased if we refer to the whole network, but if we refer to separate firms in this network, we can hardly make the conclusion that firm size has increased.

In addition, Nokia Group has in recent years also created new firms which are outside the group. This has taken place in two ways. Firstly, the group has streamlined its strategy and for this reason it has sold many less important business units. In some cases these units were not sold to other old firms but these units were organized as new firms through management-buy-out arrangements. This has been the case especially in the reorganization process of Nokia Group's old rubber industry.

Secondly, Nokia Group has externalized some part of its activities also in important business areas. To improve productivity and flexibility Nokia has externalized e.g. some software activities and manufacturing of some uncomplicated components. It can be said that these new independent units or firms are still a part of Nokia Group's network. However, there is a clear difference from the prior situation because these new units or firms sell their products not only to Nokia Group but to other companies, too.

The organizational change inside the Nokia Group has taken place at the same time as the nature of the group's outside relationships has changed. Strategic alliances, partners, cooperation and networks are among the key words as the group's top managers describe the group's future. Table 5 shows a list of Nokia's major network relationships of today. There are network relationships in R&D, production and marketing operations.

It would be useful to distinguish between two types of network relationships. The nature of some of Nokia's networks is defensive. For example, the rearrangement of Nokia's paper division as a part of a new soft-tissue alliance is clearly defensive in nature. In the CEO's Review of 1989 this alliance is justified as follows: "The paper division had been returning unsatisfactory results in recent years and its prospects of developing on its own were not good. By making it part of a major organization with sufficiently large and solid market positions in several European countries, it has been provided with a foundation for competitive operation in future years. In the agreement setting up the joint-venture, Nokia has reserved the option of withdrawing within three years."

On the other hand, in most cases Nokia's networks related to the electronics industry are offensie in nature. In this area the group tries to strengthen its position by alliances. Typical cases are ECR 9000 Cellular Telephone Consortium between AEG, Alcatel and Nokia and cooperative HDTV projets in Finland and under the umbrella of EUREKA. The motivation behind this type of networking is set out in a report by Nokia Research Center: "Nokia is investing heavily in R&D of products and production technology. However, a company of the size of Nokia cannot run a fully-fledged basic research programme in all its fields of interest. Cooperation in research is therefore both a logical choice and a must."

In 1989 Nokia invested 1 100 million FIM in R&D and its research staff was about 4 000 persons. These are very big figures in comparison to the corresponding figures for other Finnish groups but rather small when comparing them to the figures of foreign groups like IBM, Siemens, Philips, Motorola, LM Ericsson ...

All in all, the organizational change both inside and outside Nokia Group makes it a difficult task to define the 'real' (internal) and (external) boundaries of the group. For instance, from the point of view of a consumer who is going to buy a colour TV set it is not easy to know whose television he is actually buying, where it is made and what is the real competitive situation between various brand names. Nokia Consumer Electronics is a multinational organization comprising four major companies (Salora in Finland, Luxor in Sweden, Oceanic in France and Nokia Graetz in FRG) and the group uses within a single concept (Nokia- the Eurotechnology Group) several individual brand names (ITT-Nokia, Salora, Luxor, Oceanic, Schaub Lorenz, Graetz and Sonolor).

At the same time some of Nokia's factories are original equipment manufacturers (OEM) for some other foreign firms (e.g. Granada in UK and Hitachi in some European countries).

Table 5. Major Production and R&D Networks of the Nokia Group 1990

CONSUMER ELECTRONICS

- AN A-MEMBER IN EUREKA 95 HDTV-PROJECT (OTHERS: PHILIPS, THOMSON, BOSCH)
- MAJOR MEMBER IN THE FINNISH HDTV-PROJECT: RTT-COMPANY (OTHERS: THE FINNISH PTT, THE FINNISH BROADCASTING CORPORATION)
- ASSOCIATED COMPANY SELECTRONIC IN HUNGARY (35 %)
- STAFURT IN GDR MANUFACTURES NOKIA-TVs
- NOKIA-VIDEOs ARE MADE BY HITACHI
- NOKIA IS AN ORIGINAL EQUIPMENT MANUFACTURER (OEM) OF COLOUR TV SETS FOR SEVERAL FOREIGN COMPANIES

DATA

- NOKIA IMPORTS MAINFRAME AND MINI COMPUTERS AND WORKSTATIONS OF SEVERAL FOREIGN COMPANIES

MOBILE PHONES

- ECR 900 CELLULAR TELEPHONE CONSORTIUM BETWEEN AEG, ALCATEL AND NOKIA
- JOINT VENTURE NOKIA-TANDY MOBILE COMMUNICATIONS (US, KOREA REPUBLIC)
- ASSOCIATED COMPANY MATRA-NOKIA RADIOMOBILES (FRANCE)
- NOKIA IS A MINORITY SHAREHOLDER IN SHAYE COMMUNICATIONS, THE BRITISH COMPANY WHICH HAS DEVELOPED DIGITAL CORDLESS PHONE

CABLE AND MACHINERY

- JOINT VENTURE ELKAT (40 %) IN THE SOVJET UNION (MOSKABEL)
- GROUP COMPANIES TURKABLE (51 %) IN TR, NOKIA MAILLEFER (61 %) IN SWITZERLAND SLO (66 %) AND SLO-IDMAN (50 %) IN FINLAND AND NKF HOLDING IN THE NETHERLANDS

BASIC INDUSTRIES

- IN NOKIA TYRES SUMIMOTO (JAPAN) IS NOWADAYS THE PARTNER (20 %)
- NOKIA'S PAPER DIVISION IS NOWADAYS A PARTNER IN NEW JOINT VENTURE BETWEEN NOKIA, JAMES RIVER (US) AND MONTEDISON (ITALY); NOKIA HAS RESERVED THE OPTION OF WITHDRAWING WITHIN THREE YEARS

COMPONENTS

- GROUP COMPANY MICRONAS (91 %) CO-OPERATE WITH SEIKO (JAPAN) AND MICRO POWER SYSTEMS (US) IN DEVELOPING ASICs
- NOKIA CO-OPERATE WITH AT&T IN DEVELOPING MICROCIRCUITS FOR THE MOBILE PHONES

RESEARCH CENTER

- CO-ORDINATES NOKIA'S ACTIVE PARTICIPATION IN DOMESTIC AND INTERNATIONAL R&D PROGRAMMES, NOKIA PARTICIPATES IN ABOUT 20 PROJECTS IN EC-, EUREKA-, COST- AND ESA-PROGRAMMES

5. CONCLUSIONS

New flexible technologies impinge heavily on the organizational structure of firms and maybe more importantly on the industrial organization and the nature of competition. In the industrial structure the elements of a network economy are emerging, a growing part of firms' activities tend to be performed between markets and hierarchies forming a network, governed by various kinds of contracts. A competitive edge is - to an increasing degree - created via production of custom-made goods manufactured in small batches, addressed to meet the specific needs of buyers.

These developments concern, so far, mainly engineering industries. No doubt, there are many industries where the traditional mass production model will be the dominant one for long. However, some case studies show that the flexible model is adopted, mainly through organizational innovations, in many industries where opportunities to innovate with flexible technologies are limited.

Empirical evidence - though quite scattered so far - seems to be in line with predictions of the "flexibility model". The average plant size is decreasing especially in engineering where the diffusion of the new technologies has been fastest. Carlsson (1988) shows the decline by using extensive data from several countries and gives two (distinct) explanations for the phenomenon: 1) firms are specializing, i.e. selling off non-core businesses to free up scarce resources to better run the core business activities; 2) the new computer-based flexible technology improves the quality and productivity of small and medium scale production in relation to traditional mass production techniques.

In light of the discussion of this paper the two explanations are not mutually exclusive, but aspects of the same phenomenon, i.e., adoption of a coherent business strategy exploiting complementarities inherent in various activities of the firm (cf. Milgrom and Roberts, 1990). The achievment of specialization gains is contingent upon adoption of new technologies.

Although the economies of scale in production are of decreasing importance, and replaced to an increasing degree by interproduct economies, the scale seems to be more and more important in R&D and in international operations. R&D activities seem to be concentrated increasingly - at least in the Scandinavian economies - in the large corporations and firms are forming strategic networks (sometimes with rivals) to guarantee keeping up with technological advance and/or to share risks.

Networks as new modes of organizations pose quite a challenge to competition policy. Networks may be formed in order to restrict competition by contracts which guarantee monopoly position in certain deliveries. Firms (suppliers) have an incentive to invest in networks to get higher prices. From the point of view of the economy as a whole this type of strategy may lead to excess investment and welfare losses. The problem of the competition policy arises from the fact that the contracts are often not made public and the object of the policies (the firm) is not easy to identify. The traditional boundaries of firms are fading away as the contract-based inter-organizational relations begin to play a major role in industrial organization.

APPENDIX 1. The average plant size (number of persons engaged) in Finnish manufacturing by industry, 1976, 1980 and 1987

Industry		1976	1980	1987
311-2	Food manufacturing	47	48	54
313	Beverage industries	184	204	205
314	Tobacco manufactures	362	378	307
321	Manufacture of textiles	90	82	59
322	Manufacture of wearing apparel	79	76	65
323	Manuf. of leather and p. of leather	44	37	33
324	Manufacture of footwear, ex. rubber	77	74	68
331	Manufacture of wood and wood prod.	59	65	55
332	Manufacture of furniture and fixtures	56	37	35
341	Man. of paper and paper products	290	264	223
342	Printing, publishing and allied ind.	50	49	54
351	Man. of industrial chemicals	108	93	86
352	Man. of other chemical products	83	89	103
353	Petroleum refineries	892	1443	1406
354	Misc. products of petroleum and coal	39	40	37
355	Manufacture of rubber products	360	273	182
356	Man. of plastic products	51	45	44
361	Man. of pottery, china and eart.	293	156	114
362	Man. of glass and glass products	98	83	75
369	Man. of other non-metallic min. prod.	46	42	44
371	Iron and steel basic industries	264	256	229
372	Non-ferrous metal basic industries	168	161	154
381	Man. of fabricated metal products	57	48	44
382	Man. of machinery except electrical	107	92	75
383	Man. of electrical machinery, appar.	185	159	137
384	Man. of transport equipment	176	138	132
385	Man. of prof. and scientific, etc.	73	58	61
390	Other manufacturing industries	41	43	46
3	Manufacturing	83	75	70

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ELINKEINOELÄMÄN TUTKIMUSLAITOS (ETLA)
THE RESEARCH INSTITUTE OF THE FINNISH ECONOMY
LÖNNROTINKATU 4 B, SF-00120 HELSINKI

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