

The case Series in Management of Technology

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Danfoss

Corporate Strategy, Economic Organization and Management of Technology

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Foreword

This case is one of a series of cases on strategy, organization and management of technology headed by Jens Frøslev Christensen at Department of Industrial Economics and Strategy, Copenhagen Business School. The objective of these cases is twofold: to generate empirical inputs from business practice for use in ongoing research as well as in case-teaching exercises within the field of Management of Technology.

This case study of Danfoss does not pretend to give a full and final account of Danfoss. The study provides a description of the overall corporate development with a primary focus on changes in corporate organization, strategy and management of technology during the 1990s. There is a bias in the case towards a corporate top-down perspective, while the perspective from the individual divisions is missing.

We would like to thank Vice President Hans Jørgen Pedersen and Manager Vibeke Gustafsson, Danfoss, who have contributed significantly to this case through several interviews conducted since January 1996 and extending to the most recent one in April 1999. We also thank them for granting access to a number of internal documents. In addition, this case builds on many published articles and books. Historical information is primarily based on two books: Boje and Johansen: "En iværksætter" (1994), and Hansen: "Danfoss - arven fra Mads" (1994).

In September 1999 Danfoss announced the merger of its largest division, Mobile Hydraulics Division, with the large German/American company, Sauer Inc. to become effective from January 2000. Since the details of the merger and the organizational arrangements have not been settled at the time of writing, the merger will not be analyzed in this case study.

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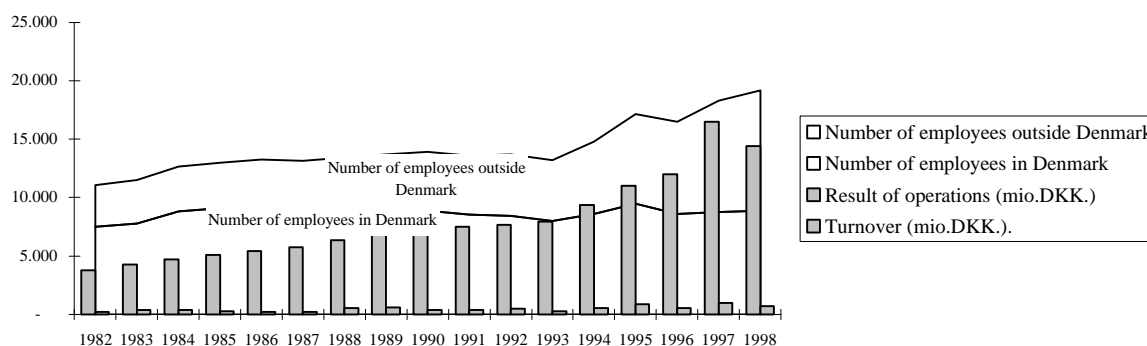
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1 Introduction

Since its establishment in 1933 Danfoss has been one of the most successful Danish manufacturing companies. Every single year of its existence Danfoss has shown a positive profit, and today Danfoss is Denmark's largest industrial group with an annual turnover of nearly 15 billion DKK and about 19,000 employees of which more than half are employed outside Denmark (Danfoss homepage). The company manufactures thousands of different products¹ and product models within, at the time of writing, 13 broader product lines, particularly mechatronical products for industrial markets such as thermostats for cooling and freezing equipment, comfort automatics (products for temperature control, radiator thermostats, etc.), cooling and air-conditioning automatics, hydraulic components and industrial instrumentation (e.g. electronic flow meters).

Most of Danfoss' products have one thing in common - they are located in technical equipment and systems to control dynamic processes. Danfoss has global market leadership within several of its product areas (e.g. some types of hydraulic equipment, intelligent cooling systems, radiator thermostats, non-CFC compressors and thermostats for refrigerators and freezers).

Figure 1: Danfoss' turnover, profits and employment 1981-1998



Annual Reports 1981-1998

1.1 Mission

Danfoss' mission statement:

1. We will produce and deliver products to the total satisfaction of our customers in global markets with a high degree of environmental consciousness.

We are a customer-oriented, worldwide supplier of technical products, services and solutions. Our products satisfy needs within the areas of energy savings, food preservati-

¹ The actual figure is impossible to assess, since most products are customized, making an almost infinite number of product varieties possible. Lately a system of product numbering with 8 digits has been given up because it proved inadequate.

on, productivity, improved comfort and environmental improvement. Danfoss seeks to accomplish these objectives with a minimum consumption of raw materials and energy, the fewest possible undesirable environmental effects and the most effective application of resources.

2. We are a committed group of people with meaningful working lives.

We are a committed group of people with meaningful working lives in an environment that supports and allows further development and fulfillment both as a team and as individuals.

3. We will globally promote the Danfoss culture while supporting and respecting local values.

We will encourage a Danfoss culture that concerns human relations, quality, products, technology and environment, based on shared values. At the same time we aim to strengthen the self-respect, pride and initiative of local entities.

4. We will seek to strengthen the societies in which we play an active role.

In our international activities we will encourage and support the pursuit of economic growth and stability for our local entities and the Danfoss Group, and thereby contribute to strengthening the societies in which we play an active role.

(Danfoss homepage 1998)

1.2 Foundation and history

Danfoss was founded by Mads Clausen in 1933 while he was working at Brdr. Gram (“the Gram Brothers”), a Danish manufacturer of refrigeration equipment. The first products manufactured by Mads Clausen in his own company were valves for refrigeration equipment copied from American models. The initial manufacturing took place in a small tool shop owned by two brothers who Mads Clausen knew from his days as an apprentice. Mads Clausen was at the same time developing a compressor for his employer, but did not start his own line of compressors until 20 years later.

Development of the first line of valves began in 1932 with sales taking off the following year, including exports to Sweden and Belgium. An old schoolmate of Mads Clausen began manufacturing the valves in Hamburg on a license from Mads Clausen in 1933, and the royalties made up more than 15% of Mads Clausen’s turnover in 1934. In September 1933 Mads Clausen quit his job in order to focus exclusively on building his own business, and in 1935 he set up his own tool shop which a year later had seven employees. Turnover tripled from 1935 to 1940 with growing exports to Norway, the Netherlands and Belgium.

While different types of valves for refrigeration equipment constituted the only business area in the early years, the product range was expanded during World War II to include equipment and components for stoking, air-pressure and water supply. World War II also created opportunities for exports to the Scandinavian countries, Belgium and the Netherlands, which were cut off from supplies from the USA and UK. Turnover in Denmark increased six-fold during the war. The increasing product and market diversification contributed to equilibrate seasonal changes in demand. The extraordinary growth through these early years can partly be explained by the fact that Danfoss was protected from competition because of import restrictions.

In 1946 the name of the company was changed from Dansk Kølleteknik og Apparat Fabrik (“Danish Cooling Technology and Apparatus Factory”) to “Danfoss” which was more convenient, especially in international markets.

In the 1950s Danfoss started manufacturing compressors and radiator thermostats for which markets were rapidly growing. The radiator thermostat exploited the emergence of central heating that increasingly came to replace individual stoking facilities in the housing sector. The growth of the compressor market reflected the massive replacement of ice boxes in households by refrigerators which required compressors. Likewise, the emergence of self-service supermarkets resulted in increased demand for components for refrigerators and freezers for use in stores.

From the mid 1960s most of Danfoss’ important product markets were coming close to saturation, so continued growth would have to be obtained by extending the geographic scope and the product range. In the 1960s and 1970s Danfoss introduced different types of hydraulic components, electronic frequency converters and flow meters. The radiator thermostat became a significant area of growth in the second half of the 1970s due to the product’s capacity to reduce energy consumption in an era of rapidly increasing energy prices.

During the 1980s Danfoss focused on developing improved versions of existing products, offering new products for existing customers, introducing products with reduced environmental effects, and delivering complete systems (for instance for complex heating regulation) that integrated electronics and precision mechanics.

Danfoss has in the 1990s begun to exploit the growing interest in “environment friendly” products. Danfoss was, for example, the first to introduce an entire range of hermetic cooling compressors with “ozone-friendly” refrigerants. The introduction of water hydraulic compo-

nents (Nessie®) in 1994 was awarded the EU Environmental prize 1995 in the category "Green Products" (Annual report 1995: 5 and 11). Danfoss' commitment to environmental issues is also reflected in the mission statement (cf. section 1.1) and the publication of a yearly environmental statement since 1995.

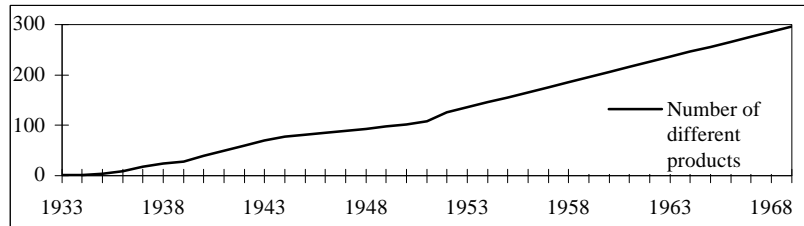
Danfoss was incorporated in 1961 but remained fully owned by Mads Clausen and his family. In 1971, six years after the death of Mads Clausen, 95% of the stocks were transferred to a family-controlled foundation whose board consists of three members of the Clausen family, three non-family members and three members elected by the employees of Danfoss. Decisions of the foundation were until 1991 made by simple majority votes, but since 1991 at least two members of the Clausen family has to vote for a proposal to be accepted (Børsens Nyhedsmagasin No. 20, 1993: 13). Danfoss has no immediate plans to enter the Danish stock market exchange (Børsen, 2. Feb. 1996).

2 Products and business areas

2.1 The expansion of the product portfolio

Up until 1940 38 new products were added to the product portfolio, all related to refrigerating or cold storage plants. During World War II another 37 products were added, and from the beginning of the 1950s the rate of new product introductions was further increased. By the end of the 1960s the product portfolio consisted of about 300 products (Boje & Johansen, 1994). There are no comparable figures accessible concerning the development during the last decades, but it seems fair to suggest that there has not been a slow-down in the rate of new product launching. On the contrary, it is likely that the number of products has risen dramatically due to increasing customization and regional adaptation as well as the tendency for shorter and shorter product life cycles.

Figure 2: Product range expansion in Danfoss 1933-1969



Boje og Johansen (1994)

A significant part of the product range expansion is reflected in the dynamics of product market diversification. Thus, from the initial focus on valves for refrigeration, new products came to include automatic equipment for stoking, heating, compressed-air, and water supply plants.

The Danfoss products are used in a wide range of application areas, for example: process industries (flow meters, valves, pressure and temperature controls, frequency converters, hydraulics, etc.), meat processing, shipbuilding, breweries, construction, district heating, waste water purification, supermarkets, and bottling.

Because of the complexity of the product range, Danfoss has no strict official policy as to which types of products should be produced, or not produced, although the annual report of 1993 describes a common field of application for most of the products:

Danfoss manufactures thousands of different products for an even larger number of applications. But most of them has one thing in common: They are going to be used in plants and systems where they are to control dynamics. (Annual Report, 1993: 7, our translation)

2.2 The product lines²

Danfoss' at present 13 product lines are divided among ten product divisions (one more division is in the preparation phase) reporting to three "product families" or groups of divisions (see table 1). The number of product lines varies because new are added, for example when a range of products achieve sufficient scale to be registered as a product line, or a new line is developed. Danfoss occasionally also sells off a product line.

² The term product line in Danfoss signifies a business unit with financial responsibility for a range of related products.

Table 1: Product lines, Divisions and Product Families in Danfoss

Product family	Division	Product lines
Refrigeration Controls: an extensive range of components for all areas of the refrigeration industry - from the household refrigerator to large process plants of the food industry.	Automatic Controls	<i>Refrigeration and Air Conditioning Controls</i> comprise a full-scale program of mechanical and electronic apparatus i.e. thermostatic expansion valves, solenoid valves, thermostats and pressostats, modulating pressure regulators, filter dryers, liquid indicators, non-return valves and water valves, and furthermore, decentralized electronic systems for full regulation and control. <i>The Pressure and Temperature Controls product line</i> consist of pressure and temperature switches, pressure transmitters, and temperature sensors and transmitters which are used in applications ranging from ship construction to food and beverage processing.
	Commercial Compressors	<i>Compressors for Commercial Refrigeration</i> consisting of a large selection of hermetic piston compressors, Scroll compressors and air-cooled condensing aggregates. The products are used in air-conditioning systems, water-cooling equipment and commercial refrigeration plant.
	Household Compressors	<i>Compressors for Refrigerators and Freezers</i> has a wide product program of hermetic compressors for all current refrigerations and voltages. <i>Thermostats for Refrigerators and Freezers</i> comprise a full CFC-free range of service thermostats and of thermostats manufactured to customer specifications, and hermetic 3/2-way valves for refrigerators and freezers, and valves for energy-saving applications.
Motion Controls: full-scale range of control components for many different branches of industry, as well as agriculture and forestry, and construction and mining operations.	Mobile Hydraulics	The <i>Fluid Power</i> product range for hydraulics covers the following types of components: low-speed high torque hydraulic motors, gear pumps, hydraulic actuators, proportional and manual directional valves, remote control devices, cartridge valves and hydrostatic steering components. The responsibility for a second, newly developed product line of <i>Water Hydraulics</i> has recently been transferred to the executive committee level. The Nessie® water hydraulic product range from Danfoss is the most comprehensive of its kind in the world, including power-packs, pumps, valves, motors, cylinders and accessories based on 44 patents.
	Drives Division	The product line called <i>Electrical Drives and Controls</i> consist of frequency converters for variable speed control of electric motors.
Heating and Water Controls: wide range of products for automatic operation, control and monitoring of every level of heat supply - from private homes to industrial buildings.	Building Controls	<i>Heating and Ventilation Controls</i> are regulators for district heating and central heating systems as self-activating pressure and temperature regulators, electronic weather compensators and domestic hot water controls, and electronic regulators for air-conditioning systems.
	Comfort Controls	The <i>Comfort Controls</i> product line includes products for temperature control, radiator thermostats, room and clock thermostats, programmers, time switches, small motor valves, and fittings components such as return connectors.
	Burner Components	<i>Components for Burners and Boilers</i> comprises components for control and monitoring of oil burners for residential heating, and for commercial and industrial purposes. It includes automatic oil burner controls, oil nozzles, oil pre-heaters, oil pumps, thermostats and ignition units.
	Instrumentation	<i>Instrumentation</i> consist of flowmeters based on the electromagnetic principle, flowmeters based on the ultrasonic transit time, ultrasonic heat meters, and mass flowmeters.
	Water Valves	<i>SOCLA* Valves</i> comprise a wide range of valves and components such as non-return valves, bottom valves, regulation valves, air dischargers, backflow preventers, ball valves, filters and rubber compensators for plant in the potable water sector. The products can also be used with other media such as waste water, liquid chemicals, gases, air, foodstuffs, etc.

SOCLA is the name of an acquired french company, which has become an independent division (Danfoss homepage and Danfoss organization chart).

The recently acquired German company, Bauer Antriebstechnik GmbH, is planned to form a new product division which will be added to the Motion Controls "product family" (as the third division). The company manufactures electric motors, gears and gear motors and has recently launched a new gear motor program which can also integrate Danfoss' frequency converters.

2.2.1 Examples of business development at Danfoss

The radiator thermostat

In 1940 a development engineer, Bror Kruse, suggested to Mads Clausen that they develop a thermostatic valve that could control the temperature in living rooms. The first prototype was tested in Mads Clausen's office and home in 1943. It was developed for central heating without circulation pumps. The developers, however, anticipated that the future of central heating would increasingly be based on pumps circulating hot water. Danfoss therefore went on to develop versions of thermostatic valves (radiator thermostats) aimed at central heating based on hot water circulation. They were tested on the market from 1948 to 1950, and marketing began in 1952 with a special focus on their comfort enhancing. The radiator thermostat was Danfoss' first high volume product to be patented. It did not, however, become a commercial success until the mid-1950s after some design improvements (Boje & Johansen, 1994: 100-101).

The central part of a radiator thermostat is a metal spring (bellows) that reacts to changes in temperature. Danfoss has manufactured bellows for use in its expanding range of thermostats since 1940 and has gradually developed strong capabilities in dedicated materials and process technologies that have made the company able to continually improve the performance of the radiator thermostat and rationalize the production (Radiator Thermostats Through 50 Years, 1993). In 1981, a development center for radiator thermostats was built in Nordborg (Annual Report 1981: 28).

In 1979 the production was moved from Nordborg to Silkeborg, where most of the production is still carried out. In recent years, however, Danfoss has set up production of radiator thermostats in Canada, Poland, Russia and China. The production of radiator thermostats acts as a frontrunner for Danfoss in establishing production abroad because it is a product that quickly reaches sufficient sales volume for profitable operation. However, the most important components are still manufactured in Denmark (Silkeborg and Viby).

The two product lines (business units), “Integrated Electronic Heating Control Systems” and “Radiator thermostats”, were merged in 1982 into the product division Heating (Annual Report 1982: 20) in order to be able to offer integrated heating control solutions. The two product lines, however, were again separated in 1994, when the production of radiator thermostats and related products achieved enough scale of operation for the product line to form an independent division (The Comfort Division) with approximately 1,000 employees (Jyllands Posten, 17. Aug. 1994).

The ability to increase comfort was the most important marketing feature of the radiator thermostat until the international energy crises of the 1970s which created more awareness about the energy saving function of the radiator thermostat³. Unlike other Danfoss products, the radiator thermostat is advertised directly to the end-user through advertising campaigns, and as early as the beginning of the 1970s TV commercials were used for promotion. This meant that the consumers were aware of the product when the energy crisis set in. In the 1990s the radiator thermostat has also been marketed as environment-friendly because reduction in energy consumption also decreases emission of toxins and pollutants, for example sulfur and CO₂ (Radiator Thermostats Through 50 Years, 1993). Danfoss is today the global market leader within the radiator thermostat business. The product line accounts for about 10% of total turnover in Danfoss.

The VLT® frequency converter

Already in the early 1950s Mads Clausen was convinced that electronics had great prospects for Danfoss, and in 1953 he hired an electronics engineer to search for ideas for products suitable for production at Danfoss. During the same period Otto Wullenweber from the nearby town of Sønderborg developed an electronic rectifier that appeared to have good market prospects, because the Danish electric power supply system was in the process of being converted from direct current (DC) to alternating current (AC). Wullenweber, however, was not successful in marketing his invention, and in 1959 Danfoss acquired the property rights for the rectifier by settling Wullenweber’s debts and hiring him as manager of a new department called Danfoss Electronics (Boje & Johansen, 1994: 216-217).

Danfoss Electronics produced customized high power rectifiers for electric railways from 1962 to 1965, but when eventually the products turned out to be non-profitable, Danfoss Electronics

³ A radiator thermostat can reduce energy consumption by up to 10 to 20%, equivalent to an annual reduction of 2.3 mio. tons of oil saved by the 200 mio. radiator thermostats produced by Danfoss.

was turned into a R&D department with 20 employees. The mission was to search for promising business areas for Danfoss based on electronics. In 1966 two engineers from the department attended a conference in London where a presenter claimed that it would be impossible to adjust the speed of AC-motors except by mechanical means. Danfoss had recently developed a rectifier based on a patented circuit employing some new types of semiconductors. This circuit became the core of the first frequency converter (AC-motor controller) introduced in 1968. Danfoss applied for 14 patents related to this new product. The aim was to develop a standardized frequency converter that could be mass-produced. The ten first prototypes were tested at selected customers in 1968. The prototypes were soon nicknamed the “carrier pigeons” because they were faulty and quickly returned by the customers. However, after substantial debugging the product finally became ready for introduction.

The frequency converter enjoyed several years of lead time before the first competitors appeared (General Electric and Strømberg). VLT[®] is Danfoss’ registered trademark for frequency converters⁴. Danfoss’ first frequency converter (VLT[®] 5) was marketed for more than ten years, but now new models are introduced every three to four years. The new models have been changed with respect to four major dimensions:

- 1) Weight: The VLT[®] 5 frequency converter weighed 54 kg., whereas the comparable model VLT[®] 3004 from 1993 weighs 14 kg.
- 2) The converters were originally analogue, but were digitalized in 1989.
- 3) Digitalization has made the frequency converters more user-friendly and they are now automatically adapted to the motor.
- 4) The frequency converters have been developed from being autonomous controllers to become part of a network of frequency converters in which every converter communicates with the rest.

The product range has been expanded several times to exploit niches made profitable by declining prices of the electronic components. Danfoss’ VLT[®] frequency converters have won several Danish and international awards⁵. Future developments are expected to focus mainly on features associated with user interface, digital communication, size and environment.

The original model was initially marketed in Denmark only, but was soon after released in the other Nordic countries and, from 1970, in the rest of Western Europe. The rights to manufac-

⁴ The letter combination VLT has no meaning but is based on one of the first suggestions for a product name, VeLoTrol, which is an abbreviation for VeLocity conTrol. Unfortunately for Danfoss, a British company had already reserved the rights for that name, so the name VLT was chosen instead.

⁵ The new generation of frequency converters is based on a new principle, Voltage Vector Control (VVC), which among industry observers is recognized as a leading control principle. Danfoss received a first prize for VVC at an European conference in 1989 (Annual Report, 1989: 11).

ture frequency converters in USA was sold to an American company in 1973. The company, however, lacked the ability to manufacture frequency converters efficiently, and in 1982/83 Danfoss started its own production of frequency converters in USA when it acquired an American distributor and manufacturer of motor controls for DC-motors. The acquisition of the American company led to a tripling of the turnover on the North American markets over three years (Annual Report 1985: 11). In 1989, the American subsidiary launched a frequency converter based on its own development.

After multiple expansions of the production site in Nordborg, production was moved to Gråsten in 1977, which increased manufacturing space to five times the space it had in Nordborg. Frequency converters became an independent product line in 1982, and the following year the product area became organized as a separate division called the Drives Division. As part of the restructuring of Danfoss, the division's marketing, administration and development departments were moved to Gråsten in 1989. The same year, the division became ISO9000-certified - one of the first frequency converter manufacturers to earn this achievement. In 1993 Danfoss' Drives Division was considered one of the leading global manufacturers of frequency converters (Historien om VLT gennem 25 år, 1993).

Lighting Controls

Currently, a new product line (Lighting Controls) is being developed as a result of collaboration between the Electronics Factory (a manufacturing center supplying both internal customers in different divisions and external customers with electronic components) and the Corporate Planning department. The Lighting Controls product line involves electronic controls for fluorescent tubes for use in industrial environments and in outdoor lighting systems. The product incorporates a device, called a ballast, that powers up the tube, and replaces electro-magnetic ballasts, capacitors and starters, and saves 20 to 25 percent in electricity costs.

The development of the lighting controls product line began when the Electronics Factory lost one of the major external customers, who switched from thick film technology supplied by the Electronics Factory to printed circuit boards produced elsewhere. The loss of this customer meant the loss of the only mass production activity in the Electronics Factory. The head of the Electronics Factory asked for permission to continue production with the objective of producing the entire product of the previous customer as a new Danfoss product (heavy duty lighting controls). After initially being rejected by the former CEO, the project received conditional acceptance by the new CEO, who thought the Comfort division (radiator thermostats)

could use a new product line to supplement its current line. The head of the Comfort division, however, refused to take responsibility for the new product because the division preferred projects related to floor heating which would be more related to its existing products. The project was then transferred to the Corporate Planning department which accepted to investigate the feasibility of the project. The original customer of the Electronics Factory had by then gone bankrupt. The feasibility study showed that the product suited the Danfoss product portfolio because it was relatively scale intensive, but not so large scale that it attracted major competitors in the lighting industry such as Philips, Osram and GE, who did not offer a similar product. The product had some flaws in quality, which Danfoss with its expertise in high quality manufacturing would be able to correct. For a modest sum, Danfoss acquired the blueprints and business contacts from the executors of the bankrupt company and hired the former sales representative, who had extensive business and customer contacts. The Planning Department is at present building a sales organization dedicated to the new line of products, but it has not yet been decided in which divisional context the new product line will be placed.

3 Strategy, organization and management

3.1 Overall strategy

The growth of Danfoss has been based on the continuous launching of new or improved products and expansion into new geographic markets and customer segments. The persistent success of Danfoss can to a large extent be explained by its ability to identify and exploit new market opportunities through the innovative application and combination of different assets in the corporate technology base and through the ability (and luck) to build new technological capabilities that mesh well with the existing ones and provide new commercial opportunities. Scale economies, effective and high-quality manufacturing, and "design for manufacturability" are critical competitive advantages of Danfoss' most important products - certainly of the most successful of them all - the radiator thermostat.

From the late 1930s the strategy of Danfoss has been to generate internal growth through mass production. Another objective was to manufacture as much as possible in Denmark/nordborg (cf. section 6.2). In 1957 the first foreign operation was established in Flensburg, Germany. Even if minor operations were established abroad, and in Denmark outside Nordborg during the 1960s, by far the largest share of Danfoss' overall production capacity remained located in Nordborg. By the end of the 1960s the policy of producing primarily in Nordborg was offi-

cially abandoned, in part as a consequence of difficulties in attracting sufficient labor to Nordborg. Since the mid 1980s many new plants have been established in, among other places, Eastern Europe and China, and today Danfoss has manufacturing facilities in 11 countries.

Danfoss established its first foreign sales subsidiaries in 1949 and by the mid 1950s Danfoss had become represented in 100 countries. The drivers of internationalization in the 1950s were to achieve efficient scale, even out fluctuations in demand and to be allowed to import materials to Denmark. Since then the drivers of internationalization has been to assure continued growth opportunities for the Danfoss group. These opportunities have increasingly been located outside Western Europe (in Asia and North and South America). Today, Danfoss has a sales presence in more than 100 countries and sales companies in 50 countries.

The first acquisition of another company occurred in 1959, when Danfoss acquired a large German manufacturer of compressors in order to strengthen Danfoss' position on the German market. Two years later, the production of compressors was moved to Danfoss' plant in Flensburg. In 1974 Danfoss made its second acquisition when it bought a Swedish company, which until then had manufactured products licensed from Danfoss and distributed other Danfoss products.

During the 1980s and 1990s Danfoss has become a more aggressive acquirer. In 1982 an American manufacturer of DC (direct current) motor controls was acquired to complement Danfoss' range of AC (alternating current)-motor controls (frequency converters). Likewise Danfoss in 1984 acquired a British flowmeter manufacturer whose electromagnetic flowmeters complemented Danfoss' ultrasonic flowmeters. Further product line extensions were carried out when Danfoss in 1990 acquired two American companies producing electric control systems, remote surveillance equipment and hydraulic valves.

Through the 1990s Danfoss has acquired companies that manufacture heating automatics, cogwheel pumps and motors (UK), hydraulic valves (USA), valves and components for water plants (France and Norway), compressors for air-conditioning and cooling installations (France), regulation valves (Slovenia), frequency converters (USA), magnetic valves (Germany) and thermostats for refrigerators (Italy). Including sales companies, Danfoss has acquired 27 companies from 1990 to January 1999 (Børsen 18. Jan. 1999:6). In March 1999 Danfoss announced the largest acquisition in Danfoss' history, the acquisition of the German company, Bauer Antriebstechnik GmbH with 950 employees and a turnover at about 680 mio. DKK (Danfoss avisen No. 6 1999).

Generally acquisitions have been pursued to strengthen market positions rather than to acquire critical R&D capabilities⁶. The general strategy for acquiring European companies has been to find companies whose products complement those of Danfoss and which can be marketed through Danfoss' existing distribution network. The objective of acquiring companies located outside Europe was also to increase capacity of distribution and create credibility in relation to local partners (Annual Report, 1992: 5).

In 1993, Jørgen Mads Clausen, then manager of Mobile Hydraulics Division, now CEO, gave an outline of the main focus areas of Danfoss as he saw them (Børsens Nyhedsmagasin, 1993):

- USA is the most important of all the new markets. In order to make Danfoss less reliant on Western European markets, where more than 80% of total turnover was generated in 1993⁷, Danfoss has begun to acquire companies in the USA, Canada and Mexico. Eastern Europe is another target area of expansion.
- The sales force of 2.500 employees shall have increased financial responsibility by reorganizing Danfoss' 22 sales subsidiaries into autonomous profit centers as part of the "Delegated Business Responsibility" plan. The objective is to increase sales pr. employee by 4-6% annually.
- Expansion and new products must to a higher degree be created through systematic acquisitions. Because time to market for new products is very long and the cost of introducing new products at least as high as development cost, expansion through acquisition is considered faster and less demanding.
- Sales synergy is considered more important than technological synergies, and therefore it is crucial that new products are targeted at existing customers.
- Danfoss must be a market-leader in order to exploit the trend towards closer user-producer interaction. The position as market-leader will often be achievable through acquisition. Once the position as market-leader has been achieved, profits can be increased by exploiting this leadership position. The position as a market-leader in one product-area will also make it easier to become market-leader in a related product-area because of a reputation effect.

In a follow up article five years later, Jørgen Mads Clausen pointed to five factors that will be decisive in driving continued growth in the future (Børsens Nyhedsmagasin, Nov. 1998: 13):

- Development and recruitment of new managers (cf. section 5.1).
- Removal of global trade barriers, especially in countries in Eastern Europe, Asia and South America where Danfoss has large market potentials.
- Acquisitions and strategic alliances are necessary to lower unit costs and develop new products.
- Globalization of operations is necessary to achieve efficient scale.

⁶ This does certainly not imply that Danfoss considers R&D capabilities strategically to be unimportant, and several of the hitherto acquired companies possess excellent R&D capabilities within their respective fields.

⁷ By the end of the 1990s this figure had declined to 75%.

- Good financial results are necessary for many reasons, but not least to be able to attract high quality employees.

3.2 Organizational development

Until 1956 Danfoss was an entrepreneurial organization strongly influenced by the founder and owner, Mads Clausen. Management was informal but centralized, because Mads Clausen wanted to supervise all activities. The first formal management team with separate responsibilities was established in 1956 with the aid of the American consultancy firm, Yulke (Hansen, 1994: 57). Danfoss was incorporated in 1961.

After the death of Mads Clausen in 1966, his wife was formally put in charge with the former chief financial officer, Andreas Jepsen as managing director (Hansen, 1994: 86)⁸. The continued expansion of the product portfolio (consisting around 1970 of more than 300 different products) and the number of markets had already before the death of the founder created administrative overload problems and subsequent discussions on how to simplify decision making.

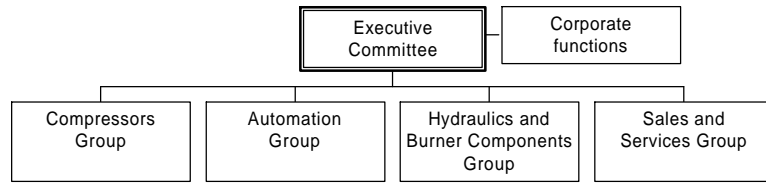
3.2.1 Early steps towards divisionalization in 1971

By the end of the 1960s, corporate management began to plan the formation of independent organizational units for each of the then six major product areas⁹. This plan was evaluated in the spring of 1971 by McKinsey & Company, who recommended the formation of three “product groups” (later to be termed “product divisions”) by merging the different product areas. Thus the three product areas, refrigeration, heating and industrial automation would merge into a product group termed Automation. Another group would be formed by merging the product areas of hydraulics and burner components. The last of the proposed product groups would comprise the product area of compressors. This new structure was implemented during 1971 (figure 3). As part of the reorganization a sales group with responsibility for direct sales and administration of the sales and service network (service shops, sales subsidiaries and sales agents) was also set up.

⁸ In 1966 the turnover of the Danfoss group came close to 500 million DKK. and the number of employees was nearly 10,000.

⁹ The term product area is used to avoid confusion with the term product line, which in Danfoss denotes a business unit with separate financial responsibility for a range of products.

Figure 3: Organization structure implemented 1971



The product groups were to build their own development, sales and accounting departments, thus making the product areas more independent of each other than before. However, substantial parts of the manufacturing and purchasing operations remained common to the three product groups. The advantages of the reorganization would, according to the consultants, be to ease operating decisions, improve strategic planning by releasing top management from dealing with operational issues, and ease the recruiting of new top managers.

Corporate management assumed responsibility for managing the functions that supported long term planning and the departments that provided service for all three product groups, including a corporate R&D function called “Corporate Technology and Research” (CTR) that had been inaugurated already in 1962. An “executive committee” was established to review plans, budgets and results, and settle conflicts among the groups.

Inherent in the plans for restructuring was the idea that the number of groups could grow when new product areas were added or existing ones increased their scale. In particular the Automation group, which was the most diverse to begin with, has undergone significant changes as individual product areas within the group have grown large enough to become independent groups. Within each of the product groups, the constituent product areas became organized in business units termed “product lines”.

3.2.2 Further decentralization by the end of the 1980s

By the mid and late 1980s it became increasingly clear for top management that the corporate organization was stuck halfway between two forms of organization, a unitary or centralized organization which represented the residual parts of the “old” Danfoss, and a divisionalized or decentralized organization representing the dynamic expansion of the product groups and their request for further autonomy. In 1988 McKinsey & Company was again summoned for advice on further reorganization.

As a result, the central purchasing function was divided among the product groups who, thus, assumed full responsibility for their own purchases. Furthermore, parts of the hitherto central manufacture of components were transferred, in terms of organizational control and financial responsibility, to the product groups. However, manufacture of components (electronics, plastic and other components) used in large quantities by multiple product groups remained under central control in Nordborg. The decentralization implied more freedom for the product groups (and product lines) to choose alternative suppliers and to base transfer prices on full costs instead of mandated internal transfers. The corporate functions were also mandated to charge payment from the product groups for services other than services concerning the long-term development of the corporation (Annual Report, 1988 and the Danfoss Newspaper no. 21 - 3. dec. 1987).

Following advice from the Boston Consulting Group, the sales subsidiaries became autonomous profit centers and under certain conditions they were allowed to sell complementary products from companies other than Danfoss (cf. section 4). At the central level, the sales group was divided into two sales divisions with responsibility for separate geographic regions.

Collectively, these changes meant further organizational and financial decentralization, including important moves towards implementing an “internal market” organization. Parallel to the organizational changes were attempts to increase the geographic co-location of each of the product groups’ production and administration units. For example, the production of compressors became concentrated in the factory in Flensburg, and the administration of the electric drives and controls product group (now Drives Division), formed in 1983, was moved from Nordborg to the product group’s factory in Gråsten.

In the early 1990s the term product group was replaced by the term division. Since 1971 seven new product groups or divisions have been established. The three original product groups have developed into what is today the largest product divisions in Danfoss (Automatic Controls, Household Compressors, and Mobile Hydraulics divisions). Each of these divisions is about twice the size of the next largest of the present divisions, the Comfort Division and the Drives Division. The other five divisions are even smaller, the Instrumentation division being the smallest with a present turnover of about 10% of the largest division (Danfoss does not reveal the actual figures). In March 1999 Danfoss announced that a new product division will be formed, termed Gearmotors division. This will comprise Danfoss’ latest acquisition, the German Bauer Antriebstechnik GmbH (cf. section 3.1).

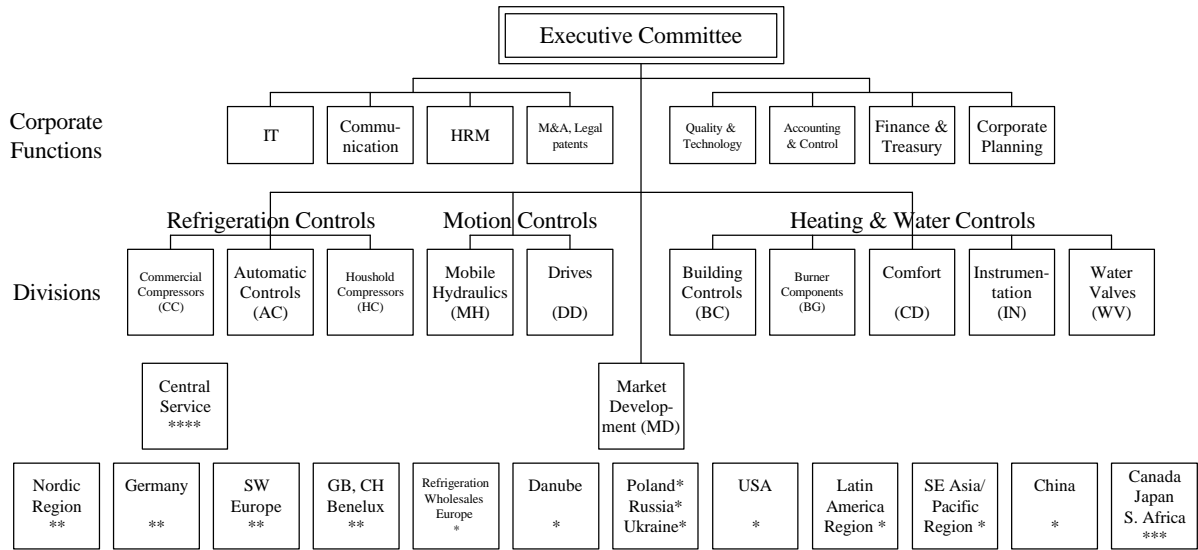
3.2.3 Major reorganizations by the end of the 1990s

In 1996 Danfoss again underwent major reorganizations (cf. figure 4). The ten product divisions were grouped into three “product families” (divisional groups), Refrigeration Controls, Motion Controls, and Heating and Water Controls. The divisions were grouped according to the criteria of similarity and common interest. With the establishment of the “product families”, the members of the executive board were relieved of their previous duties as divisional managers and could instead concentrate fully on the management of corporate affairs. Three of the four members of the executive board, including the CEO, now function as “chairman of the board” for their assigned “product family”.

The “product families” do not have their own staff and joint functions except for Refrigeration Controls, which has established a joint R&D unit that supports projects in the field of refrigeration technology. The other two “product families” do not share functions or activities at “product family”-level, except for a few bilateral coordination projects concerning marketing (in Heating and Water Controls between the Comfort Controls and Building Controls Divisions) and technology substitution (in Motion Controls between the Mobile Hydraulics and Drives Divisions). Despite increased decentralization, interdivisional cooperation seems to have increased during the 1990s, especially between divisions within the same “product family”.

The corporate staff functions also underwent major reorganization. The corporate R&D laboratory (CTR) was closed in order to strengthen the divisions’ responsibility for their own R&D activities (for further discussion, see section 7.1). The staff and projects were relocated to other parts of the corporate organization. Some were transferred to one of the three newly

Figure 4: Danfoss' organization structure implemented 1996/97



**** Owned by the divisions

Regional Sales: * Reports to the board ** Regional reporting to Divisions *** Reports to MD

formed corporate departments (Corporate Planning¹⁰, M&A¹¹, Quality and Technology).

Others were transferred to the Central Service department that provides technical extension services to the divisions (who now own the department). Still others were transferred to different divisions (see further section 7.1). A new Information Technology department, and a Communication department were also set up as corporate functions. The corporate functions for Accounting, Finance and Human Resource Management continue more or less as before. As a consequence of the restructuring and decentralization of corporate functions the number of employees in corporate functions has been reduced from 1,700 to only about 100 (Danfoss Annual Report 1997, p. 4).

Perhaps the most radical change has taken place in the sales organization, where the two regional sales divisions were dismantled. Instead the product lines (within the divisions) assumed responsibility for their own sales activities and expenses. The sales personnel in the national sales subsidiaries now report directly to the product lines (cf. section 4).

At the corporate level a small sales organization, the Market Development Division (MD), has been retained with the responsibility: a) to market products in geographic areas that are too

¹⁰ The new Corporate Planning department was already closed again in 1999. Its task profile was quite diverse comprising such areas as corporate strategic planning, management of technology, and venture projects. When it closed the strategic planning tasks were transferred to the Mergers and Acquisitions department, the technology management tasks to the Quality and Technology department, and the venture projects to a new Corporate Venture department (cf. section 7.1).

¹¹ Mergers and Acquisitions department which also includes legal and patent services. In 1999 this department has taken over the area of corporate strategic planning from the Corporate Planning department which was closed.

small for individual product lines to establish sales offices, b) to contribute to fill the gaps in Danfoss' product range and coordinate marketing collaboration among product lines (cf. section 4).

As another part of the reorganization, ownership and control over the manufacturing centers were transferred to divisional level. The product divisions today share ownership of the manufacturing centers while the responsibility to control operations has been allocated to the largest internal customer (division). The centers operate as independent profit centers supplying both internal and external customers, and since there are no mandated transfers, the centers compete with external suppliers for the orders (cf. section 6.2).

Each of the foreign manufacturing operations is owned and controlled by one division. Sometimes, however, a new operation is established in a building owned by another division in which case the new operation rents the space from the division that owns the building. The Comfort division is often the first to set up production in new regional markets because its primary product, the radiator thermostat, is comparably easy to introduce into new markets and rather quickly obtains sufficient volume for efficient manufacturing. Before manufacturing is set up, other divisions are asked for their plans for the region, so that room for expansion and new activities can be planned for. The manager of a local production unit will offer only limited assistance to other divisions setting up new operations in his country, and he is not rewarded for doing so.

3.3 Corporate management

Decision making responsibilities have extensively been delegated to divisional management, even the right to implement, for example, large development projects or major acquisitions. The corporate function for Mergers & Acquisitions assists in negotiations and analysis when a division wish to acquire a company. Generally, the involvement of the executive committee in the affairs of the individual division depends on the perceived need. The executive committee does not interfere with divisions with satisfactory financial performance, but intervenes if a division's results are unsatisfactory over a longer period or if its development activities have strategic importance for larger parts of the corporation.

Collaboration among divisions is coordinated through a number of cross-divisional committees and councils. There are seven cross-divisional committees for, respectively, standardization, marketing, purchasing, quality assurance, production technology, product development and

information technology. The committees consist of members from different divisions and corporate functions. The committee for standardization has 12 councils called “Technical Advisory Groups” (TAGs) overseeing

- construction,
- quality assurance,
- production equipment and logistics,
- sales/marketing,
- purchasing,
- information technology,
- design and corporate identity,
- plants and transport,
- environment,
- human resource management,
- finance, and
- components and materials.

The members of the committees are appointed by the executive committee, while the members of the TAGs are appointed by divisional management. Since the end of the 1980s Danfoss has also systematically promoted inter-divisional efforts in nurturing key technologies of importance for more than one division (see section 7.2).

Among the corporate management’s control and coordination mechanisms are so-called perspective plans. These plans contain information on each division’s plans for the coming three years, and explanations for deviations from the budgets contained in the previous perspective plans. The perspective plans are developed in connection with the budget-making procedure. The executive committee has in recent years, although not every year, initiated the development of the perspective plans by suggesting a theme (for example how to create and exploit core competencies or improve cash management) for the year’s perspective plan to the managers of the divisions. Divisional management then collects information from department managers and writes up the perspective plan which is delivered to the executive committee four months later. The executive committee then reviews the plans and may suggest possible changes.

The format of the “perspective plans” has recently undergone review, which has led to the development of a new standardized format to be followed by every division. This format, which has been developed in cooperation with McKinsey and Company, has a limit of 17 pages and has to be followed by all divisions in order to facilitate comparison of results and allow consolidation of forecasts at the product family level. A core feature of the new way of reporting

is the inclusion of a trend analysis for the industries in which divisions operate. The divisions will also have to identify present, developing and future core businesses for the next five years.

In addition, the executive committee receives monthly and quarterly reports from divisional management. Plans for projects running more than three years are reported on ad-hoc basis.

The executive committee sometimes suggests projects to divisional management, but divisions are not obliged to accept the proposals.

4 The organization of sales and marketing

Danfoss established its first foreign sales subsidiaries in 1949. In 1957, Danfoss began to establish service shops for servicing its products. However, the importance of these shops has gradually decreased as it became cheaper to replace defective components than to repair them. By 1965, Danfoss had become represented in most Western European countries. During the 1960s sales outside Denmark and Germany increased from 50% to 70% of total turnover. In the 1970s, an increasing part of sales was conducted through sales subsidiaries, and during the 1980s Danfoss began to establish subsidiaries in Asia and North and South America. After the collapse of the Iron Curtain sales subsidiaries have extensively been established in Eastern Europe. Today, Danfoss has a sales presence in more than 100 countries and sales companies in 50 countries.

As part of the early steps towards divisionalization in 1971 the product groups (divisions) were to build their own sales departments. Moreover a sales group with responsibility for direct sales and administration of the sales and service network (service departments, sales companies and sales agents) was established. This sales group was later divided into two divisions with responsibility for separate geographic regions.

By the end of the 1980s the sales companies became more autonomous. They became organized as individual profit centers with the objective to increase the productivity of the sales force. They were also allowed to sell complementary products from companies other than Danfoss, provided the products met Danfoss' standards for quality and did not use the Danfoss brand.

As part of the major reorganizations in 1996 the sales organization was also radically transformed. The two regional sales divisions were dismantled and most of the sales personnel divided among the product lines (within the divisions), who assumed responsibility for their own sales activities and costs. While most of the sales personnel has remained located in the national sa-

les subsidiaries they now report directly to the product lines and not to a sales division. From the existing sales organization 12 regional sales organizations were formed (cf. figure 4 in section 3.2.3) with separate subunits for each product line in high volume markets. Sales offices in smaller countries or regions where Danfoss has no local manufacturing activities operate as if they were independent sales agents with the right to refuse to market and sell products that are not sufficiently profitable, or to renegotiate prices with the supplying product lines.

A small residual of the central sales organization has been retained at the corporate level, the Market Development Division (MD). One of the responsibilities of MD is to market products in geographic areas that are too small for individual product lines to establish sales offices. Another objective is to contribute to filling the gaps in Danfoss' product range and coordinate marketing across product lines. Thus, MD is targeting specific "Strategic Business Areas" (SBAs) where products from different product lines can be marketed collectively for a specific application¹². Apart from the limited SBA activities of MD, sales and marketing is carried out by separate sales organizations for each product line. There have previously been attempts to pursue "cross product line selling". However, these attempts have not generally been perceived as successful, and moreover, they have tended to obscure the actual costs of selling individual products. So today there is no general incentive system to promote "cross product line selling".

The general acquisition strategy has been to acquire companies whose products complement those of Danfoss and can be marketed through Danfoss' existing sales and distribution network. Most of Danfoss' products are targeted at industrial markets through business-to-business marketing that increasingly requires close user-producer interaction. Danfoss has systematically tried to exploit well-established market positions and user-producer relations by introducing new complementary products (through acquisitions or internal development) to existing users and customers. This strategy contributes to increase the productivity and capacity of the existing sales and distribution systems as well as the credibility and reputation among local partners.

¹² The first SBA is water supply and -purification in Asia. Danfoss offers a full range of components for operating for example water purification plants (e.g. electromagnetic flowmeters and oxygen meters for exact measurement, frequency converters for controlling the electrical motors, pressure transmitters for overload protection and non-return valves matching the flowmeters). These products are otherwise marketed independently by the responsible product lines, but coordinated effort might be beneficial. Other potential SBA's include shipbuilding and heating, ventilation and air-conditioning (Danfoss newspaper, no. 20, 1998: 8-9).

5 Human resource policies

5.1 Human resource policies for managers¹³

By far the most of Danfoss' managers are recruited within the company. The salaries for managers consist of a combination of a fixed pay and a bonus system. The fixed pay is determined by the content of the job in comparison with the level of pay for similar positions in other companies (i.e. a market price), and an evaluation of the manager's performance in the job (e.g. low, on, or above average). The bonus is determined by a combination of Danfoss' overall performance, a number of quantitative measures, and a few qualitative measures of the performance of the manager's department.

A study by the management consultant Paul Evans inspired corporate management to emphasize managerial job rotation¹⁴. A project was launched in 1989 after which the corporate department for Human Resource Management every year distributes information to divisional managers concerning how long the managers in their division have occupied their current position. Each manager's position is then discussed between the manager and his superior. By 1995, 67% of the managers had spend less than four years in their current position, 20% between four and seven years, and only 13% more than seven years¹⁵. However, the number of years in the current position is not the only criteria for job assignment, and it is acknowledged that the contents of certain jobs evolve over time.

When a managerial position at Danfoss becomes vacant a replacement is first sought among managers at a similar level. Failing that, another manager is promoted or someone outside Danfoss is hired. In that way new opportunities for job rotation are continuously created. This system allows managers to try a number of different positions early on in their career so that their general management skills and personal network within the organization are developed. Because of Danfoss' globalization strategy, promotion to managerial positions in principle requires experience from working or studying abroad.

Danfoss is also trying to make it more prestigious to work as specialist by creating new titles and jobs such as senior consultants and project managers. Moreover, Danfoss uses internatio-

¹³ Apart from the information on the salary structure for managers, this section is primarily based on an article in *Berlingske Tidende* (Danisk newspaper): 4. Feb. 1996.

¹⁴ His study showed that managers tend to develop their skills substantially in the first year of filling their position. The next four years skills tend to stabilize followed by a decrease caused by decreasing commitment. After seven to ten years managers stop adding value to their positions, and after ten years in the same position performance start to decline.

¹⁵ These figures only concern managers of Danish nationality.

nal management schools and internal programs for upgrading managerial skills. Many of these courses are taking place outside Denmark, emphasizing Danfoss' commitment to globalization.

5.2 Human resource policies for employees in production

In its very early years Danfoss primarily employed skilled labor, but by 1945 60% of the labor force was unskilled labor and this figure increased to 85% in 1954. The main reasons for this development was increasing automation and mechanization of production as well as problems in attracting skilled labor.

Danfoss introduced piece rate wages in 1950, which was a bit later than comparable companies. Danfoss was, however, quicker to introduce bonuses for suggestions that could improve efficiency. Thus, by the mid 1950s the rule was that workers received the equivalence of three months savings on wages and materials if their suggestion for improvement was implemented (Hansen, 1994: 122-123). In 1966, when most workers earned piece rate wages, a group-based bonus system was set up for tasks whose outcome was not traceable to a single worker.

In 1971 and 1972 Danfoss, along with six other Danish manufacturing companies, took part in an experiment of: a) establishing work groups instead of the old system of conveyer belts, and b) awarding workers based on the number of hours they worked rather than on the piece rate system. The experiment proved successful and was expanded to include all manufacturing departments the following year.

Since 1991 Danfoss has gradually implemented a wage system where wages in part is determined by the overall results of the department. Wages are now made up of three components:

(PLS Consult, 1995: 25)

- A base salary depending on the task and qualifications of the worker. Unskilled labor is divided into five groups depending on the number of courses they have completed.
- An outcome based salary depending on the results of the department.
- A salary based on assessment of the workers knowledge of the task, and his or her flexibility, efficiency and initiative.

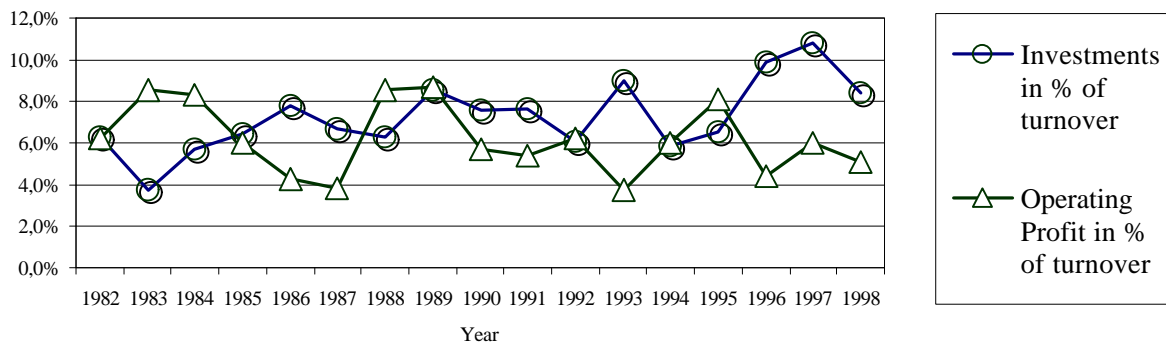
6 Manufacturing strategy and organization of production

6.1 Manufacturing strategy

Danfoss is an engineering and manufacturing oriented company. Approximately 10% of the work force have degrees in engineering. From the late 1930s Danfoss has been strongly oriented towards state of the art manufacturing, mass production and quality control techniques¹⁶.

The development and production of manufacturing equipment is, for the most part, done by suppliers based on specifications from Danfoss. Danfoss has tended to invest more of its turnover in production equipment than its competitors. In order to minimize excess investment a target of 15% ROI has been mandated in addition to required considerations concerning flexibility, safety, environment, maintenance, technology development and employment. If an investment is considered uncertain, Danfoss policy demands that such investment is minimized even if it means higher total manufacturing cost.

Figure 5: Danfoss' investments and profit in % of turnover 1981-1998



Annual Reports 1981-1998

Danfoss' manufacturing policy has a strong focus on finding the best suppliers and on continuously improving the utilization of process equipment. Certain R&D projects are concerned with development of manufacturing equipment that can be utilized both in Danfoss' own plants and be sold to other manufacturers. One such example is the development of a line of vision equipment that monitors industrial processes. Danfoss also conducts R&D in materials technology and manufacturing processes of strategic importance for the corporation.

Decisions concerning outsourcing of manufacture are based on analyses of the suppliers' ability to supply products or components that meet the required specifications on time at a cost that is

¹⁶ This was already reflected in the personal engagement of the founder, Mads Clausen who, for example, in 1949 visited 36 very efficient American manufacturing companies to identify what Danfoss could learn from their production methods.

lower than the full cost, including cost of capital, of internal manufacture. Moreover, suppliers are evaluated with respect to their willingness to accommodate large fluctuations in demand. Danfoss also considers whether cooperation with suppliers may imply access to new know-how that is of strategic importance to Danfoss, or imply a risk of diffusion of know-how that Danfoss wants to keep proprietary.

Since 1972 Danfoss has maintained and improved its quality control systems. Dedicated quality control advisory groups have been set up leading to BS5750 Part 1 certification in 1985 and ISO-9001 certification in 1989 as one of the first companies of its kind. All Danfoss companies must fulfill the requirements of the company's ISO 9000 standard. Despite many years of effort in the field of quality control, it remains a high priority issue for top and divisional management to promote a culture of "quality comes first" throughout the organization. In recent years the concept of quality has been extended from a focus on quality of products to include quality of development, manufacturing and other business processes.

6.2 The organization of production

Up until the late 1960s Danfoss' policy was to manufacture as much as possible in Denmark (Nordborg), unless production was disadvantaged by taxes and tariffs in importing countries. The first foreign operation was established in 1957 in Flensburg in Germany in order to avoid import restrictions introduced by the countries of the Coal and Steel Union (later to become the European Union). Tax considerations also motivated the establishment of a plant in 1960 in Australia, which was closed in 1971 because of insufficient volume. Minor operations in Canada, Japan, India, England, Italy and Spain, as well as smaller plants in Denmark outside Nordborg, were also established during the 1960s. As mentioned in section 3.1 the policy of producing primarily in Nordborg was abandoned by the end of the 1960s. From 1975 to the mid 1980s Danfoss did not establish new production sites, but particularly in the 1990s many new plants have been established in, among other places, Eastern Europe and China, and today Danfoss has manufacturing facilities in 11 countries. In 1997 the number of employees outside Denmark for the first time exceeded the number of employees in Denmark.

The growing internationalization of production reflected both the parallel process of divisionalization and decentralization that was initiated in the early 1970s (cf. section 3.2.1), and the acquisition strategy that gained momentum during the 1980s and 90s. Production facilities have increasingly become controlled by the divisions, implying among other things a gradual in-

tegration of administration and the main production facilities of the individual divisions. By the end of the 1980s only the manufacture of components used in large quantities by multiple divisions remained centralized under corporate responsibility¹⁷. Internal sourcing from these central plants was still considered strategic, among other things to maintain Danfoss' reputation for high quality products, to sustain manufacturing capabilities and secure employment levels, thus putting pressure on the divisions to buy from the corporate plants. However, decentralization measures implied more freedom for the divisions and product lines to choose alternative suppliers, and this was further stimulated by the implementation of mandated full cost rather than subsidized transfer prices.

As part of the reorganizations by the end of the 1990s, ownership and control over the central manufacturing plants were transferred to divisional level. The product divisions today share ownership of the manufacturing centers, while control over operations has been allocated to the largest internal customer (division). The plants are, however, supposed to operate as independent profit centers supplying both internal and external customers. The manufacturing centers compete with external suppliers for orders, since subsidized transfers have been abolished. Transfer prices are based on a target profit for the center set by its board of directors that comprise divisional managers. The central manufacturing plants have grown in size in the last couple of years despite more divisional freedom to source components from external suppliers. Today they employ nearly 1,000 people. Even though growth is partly due to increased sales to external customers, external sales are still modest. This indicates that significant advantages of shared manufacturing assets are obtained and that the advantages may have increased with the exposition to competition from external suppliers.

The divisional ownership and control over the manufacturing centers has also stimulated divisional use of technical expertise in the manufacturing centers. Thus, for example, employees from the manufacturing centers participate in divisional product development projects as consultants in process technology, and do occasionally undertake development activities on behalf of the buying division.

¹⁷ These central plants produce electronic circuits, plastic components, springs, stamped or cold forged objects and surface treated components. They are all located in Nordborg.

7 The corporate organization of innovation and technological development

In the 1960s Danfoss was a quickly growing functionally organized company with a conventional R&D lab, Corporate Technology and Research (CTR). In 1971 Danfoss initiated a process of divisionalization and established three product divisions (product groups) that were to build separate R&D departments. However, since many technologies were considered common to more than one division, CTR was retained in order to serve the common interest of all divisions. As the product range and the size and number of divisions expanded up through the 1970s, and the divisions gained more influence on the types of activities performed in CTR through their provision of financial resources, CTR became more of a pool of experts providing assistance in divisional development projects than an initiator of corporate wide technology development. This resulted in increasing numbers of small projects without much coherence and overall guidance. This tendency was reversed in the 1980s. Under the direction of Jørgen M. Clausen, son of the founder of Danfoss and present CEO of Danfoss, CTR regained significant autonomy and began to focus on a more limited number of strategic R&D and venture projects involving prospects for product market diversification. As a result, the previous close links to divisional development projects were reduced, and a quite clear-cut division of labor between on the one hand the longer term venture and R&D projects in CTR, and on the other hand the shorter term product and process development activities in the divisions. It seems fair to conclude that this development also to a large extent implied a decoupling of CTR and divisional activities.

Gradually the product divisions had also grown so large that they became capable of managing their own R&D within their respective business domains, including - to some extent - venture projects. This resulted in a substantial transformation of CTR from a R&D lab to a center for corporate technology management (and more or less related services) that transcended the traditional role of the corporate R&D lab, even if R&D still played an important role. While most of R&D in Danfoss was carried out in CTR in the 1960s and early 1970s, the CTR-based R&D in the early and mid 1990s only covered about 20% of total R&D in Danfoss, corresponding to approximately 2.4% of the company's turnover¹⁸. By then around one fourth of total costs in CTR was financed by the divisions.

¹⁸ Divisional R&D expenditure varied from 2% to 10% of divisional turnover

Consequently, other activities than R&D-projects successively came to play a relatively increasing role within CTR: technical services (consultants providing technical and procedural assistance to the divisions), management of patents, standardization and certification, quality control, and management of technology across the corporation. We shall return to the latter in section 7.2. Moreover, by the early 1990s, CTR established 10 “competence centers” with the aim of obtaining critical mass in the development and mastery of high-priority capabilities which required more effort than would likely be assigned in a single division¹⁹. Each of these centers were assigned a group of specialist personnel.

7.1 Consequences of the major reorganization by the end of the 1990s

As part of the major reorganization in 1996 (cf. section 3.2.3) the radical decision was taken to close CTR which by then had 150 employees. This was done to spur divisional management to take full responsibility for R&D and to more thoroughly integrate technology and business strategies. Top management felt that the existence of CTR tended to become an excuse for not building sufficient technological capabilities at divisional levels. Two types of problems were considered to be associated with the CTR-model. First, there was only limited communication and interaction between the divisions and CTR. Secondly, the funding of CTR constituted an increasing problem. The corporate funding of basic CTR activities was taken out of the divisional budgets, and thus, imposed on the divisions as a sort of tax, and divisional management tended to oppose this model arguing that the divisions did not get (enough) value for their money.

The various parts of the CTR staff and their associated activities were reallocated as follows:

- Some R&D projects and the quality control activities were moved to divisional level. The Refrigeration “product family” has, for example, continued a former CTR project that is now funded by the three divisions constituting the “product family”.
- The CTR staff which dealt with technical services was transferred to a Central Service department, which is owned by the divisions and operates as a consulting or technological extension service center on projects related to standardization, approvals, materials technologies, IT development, production services and man-machine interfaces. These activities are

¹⁹ The competence centers were centers for Control Engineering, Man Machine Interaction, Materials and Process Technologies, Product Development Technology, Actuators, Sensors and Microsystems, Intellectual Property Rights, Methods and Management Philosophies for Continuous Improvement and Quality Control, Standardization, Certification and Metrology, and Manufacturing Development.

primarily funded by the divisions on hourly rates²⁰, framework agreements, special offers, or subscriptions. However, some projects pertaining to, for example, corporate standardization are funded by the executive board and the Corporate Planning department which was also established in 1996 as part of the reorganization.

- The new Corporate Planning department became responsible for ongoing business development projects and new ventures, as well as the management of technology activities that were previously located in the CTR (see section 7.2). While corporate R&D projects earlier were initiated, carried out, and for the most part financed by CTR, possibly with additional funding from the divisions, the Corporate Planning department was given the option to fund 50% of R&D and venture projects if the proposals: a) are backed up by at least two divisions, b) have a long-term explorative perspective, and c) do not have a natural home base within one of the divisions. One current example is a project aimed at upgrading the software development competence with the participation of seven product lines, where a small team from the corporate level coordinates a number of independent software development projects which, beside developing specific software components, aim at accumulating and sharing experience in software development.
- Of the “competence centers” two were dismantled, while another was divided between the Household Compressors division and the Drives Division. The rest were retained in the Corporate Planning department or in the Central Service department. Establishment of new competence centers will presumably not take place at the corporate level, since it will now be the responsibility of interested product divisions or product families, for example through collaboration with other divisions, to set up competence development activities.
- The remaining activities of the CTR lab were split up among different corporate functional units. Some projects and activities related to quality management, process development, environment and supply chain management were placed in a new Quality and Technology department²¹. The patenting unit was merged with other legal advisory services and a unit assisting in mergers and acquisitions to form a separate corporate department called M&A, Legal and Patents.

²⁰ The rates have approximately doubled since the reorganization meaning that the divisions now pay all costs of running the function.

²¹ The Quality and Technology department is also working on developing non-financial performance measures.

These changes were subsequently evaluated and McKinsey & Company assisted in the process of further changes in the strategic planning process. As a result, the Corporate Planning department was closed in 1999 and the corporate venture and business development projects²² were organized within a new department that is to focus exclusively on venturing projects (for an extended discussion, see Børsens Nyhedsmagasin, May 1999). The strategic intent behind this reorganization is to revitalize the tradition in Danfoss for entrepreneurial business venturing. This does not imply that all venturing activity will take place at corporate level. There will continue to be venture activities at divisional level as well, but now for the first time Danfoss has set up a corporate function with the only objective being to support this kind of projects. Finally, the technology management activities were once again transferred, this time from the Corporate Planning department to the Quality and Technology department.

These restructurations with respect to R&D and management of technology activities - and especially the closure of CTR - have not been implemented with the intention to downsize overall R&D investments. The objective has been to create a stronger bottom-up commitment to R&D in which the location of ownership and responsibility is considered a key issue. This is reflected in the project sponsoring scheme (referred to above) to stimulate a bottom-up commitment to long-term coordinated R&D.

It is too early to make any certain judgement of the implications of the CTR-closure. A likely scenario is that the overall central guidance of the corporate technology base will be somewhat reduced. Likewise, long-term explorative R&D may be reduced, at least at the shorter term. In the longer term, however, this will depend on the extent to which: a) individual divisions build their own explorative R&D-capacities, and/or b) corporate and divisional co-sponsorship will be organized based on project proposals from at least two divisions.

From a concentration of all R&D activities in one central R&D laboratory, innovative activities have since the early 1970s gradually been spread to an increasing number of locations at four different organizational levels: the corporate level (strongly reduced activities particularly after the closure of CTR), the “product family” level (so far only activities in the Refrigeration “product family”), the divisional level (strongly increasing activities due, among other things, to the increasing number and size of divisions), and the business unit level (strongly increasing activities due, among other things, to the increasing number of acquisitions). While product

²² Danfoss Videk, Danfoss Analytical, Lighting Controls, and Functional Surface Technologies. Each of these venture

development activities increasingly take place in some of the foreign subsidiaries (for example development of compressors for refrigerators and freezers in Mexico and large frequency transformers in the USA), most of the fundamental technology development still takes place in Denmark. This pattern may, however, be changing due to the aggressive acquisition policy (see section 3.1). Since an increasing number of acquired companies possesses strong R&D capabilities, it is likely that not only product and process development but also fundamental technology development will increasingly be conducted abroad.

7.2 Corporate management of technology in Danfoss

Product market diversification has been a decisive force driving the growth of Danfoss (cf. section 1.2 and 2.1), but so has technology diversification. Therefore, for example, the primarily mechanical engineering base of the early Danfoss era has been supplemented by capabilities in electronics (see section 2.2.1 on the development of the frequency converter business) since the 1950s. Capabilities in hydraulics have become a decisive corporate asset from the 1960s and onwards²³, and during the last two to three decades capabilities within software and mechatronics have been added to the corporate technology base. Other more specific technical capabilities (i.e. stainless steel technology, computational fluid dynamics) have also been developed in the context of the expanding product portfolio.

During the first half of the 1990s Corporate Technology and Research (CTR) focused strongly on the creation of synergies across product lines and technologies in the corporation. In 1989 the director of CTR and a couple of R&D managers from the divisions began exploring the opportunities for promoting cross-divisional sharing of technologies. These efforts were prompted by the executive committee, which was anxious about the possible negative effect of the increasing decentralization of R&D for the overall coherence of the corporation. With assistance from both heads of development, manufacturing and marketing, as well as from the executive committee, a new tool called the Technology Pyramid was developed with the aim of contributing to the creation and diffusion of technological capabilities. In 1991, the responsibility for the Technology Pyramid was assigned to CTR, which as a result added a new role to the department.

projects has its own board.

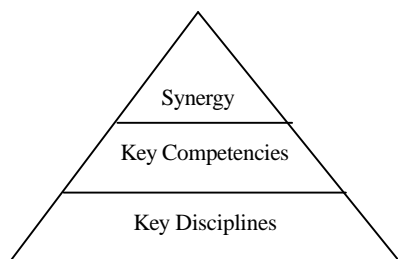
²³ This asset was initiated by the founder of Danfoss as he in 1959 decided to go into partnership production of harvester threshers (combines) - a quite unrelated product market diversification. The production was stopped in 1962 after significant loss. However, Danfoss continued to produce hydraulic components for combines and gradually hydraulic equipment became one of the most important product areas and hydraulics a high-level capability area in Danfoss.

The Technology Pyramid contains a selection of technologies in which Danfoss can (or wants to) claim world-class expertise. These technologies have significant value for more than one division²⁴. In other words, the Technology Pyramid is not a total directory of the corporate technology base (the complete portfolio of technological capabilities)²⁵. It is a continuous reflection of the strategic prospects and priorities for the corporate technology base. At the same time it is a tool to promote inter-divisional coordination and build integrated competencies across different parts of the corporate organization. Thus, the Technology Pyramid is not static but regularly subject to analysis and changes, especially regarding the technologies under consideration.

“Synergy” was situated as the top of the Technology Pyramid in 1996 reflecting the overall ambition and common denominator of the Technology Pyramid²⁶. Danfoss defines synergy as:

“... a net improvement in output, margins, or some other measure of performance that can be reliably traced to structured, purposeful collaboration among different units or to the merging of two or more units.”

Figure 6: Danfoss' Technology Pyramid 1996



At the next level in the pyramid were seven “key competencies” defined as those capabilities in which Danfoss wishes to achieve global leadership. Four competencies were primarily related to product technology (e.g. “control engineering”, “mechatronics”, “man-machine interface” and “product development technology”), while two were related to process technology (“methods and management philosophy for continuous improvement”, and “materials and processes”).

The last key competence was “business concept development”. The aim was to turn key competencies into core competencies, which Danfoss defines as a complex mesh of knowledge and skills that make its products and services better than anyone else’s. Danfoss’ ability to select, exploit and develop the right core competencies is considered crucial to the present and future competitiveness of the corporation. Developing and maintaining core competencies is considered to require so much effort that Danfoss is only able to focus on five to eight of them at a time.

²⁴ For technologies that are only important to one division, the division in question is expected to take full responsibility.

²⁵ Danfoss also has a directory listing the technological expertise of every employee involved in engineering.

²⁶ In 1996, “synergy” replaced the original five key areas of “management”, “management of technology”, “continuous improvements”, “total marketing management” and “time based competition”, which were never clearly operationalized into active programs.

The lowest level of the Technology Pyramid contained the “key disciplines”, defined as the capabilities that Danfoss wants to master on a level equal to the best of its competitors. In 1996, several of the initially 29 disciplines were withdrawn from the pyramid, either because they were considered well-established (five disciplines), or because they had failed to show the anticipated potential (nine disciplines were kept under observation). Additional “key disciplines” were also introduced, and of the total number of 20 “key disciplines” in 1996, eight were predominantly related to product technology, seven primarily to process technology, and five to marketing and management²⁷.

Since 1996 the attempts to distinguish between “key competencies” and “key disciplines” have been given up and the two categories have been fused into the notion of “key technologies”. In order to focus and strengthen the commitment and efforts of the technology management ambitions, the altogether 27 “key competencies” and “key disciplines” were reduced to 12 “key technologies”²⁸. These technologies have received more resources than were assigned before. The emphasis has shifted from a mix of R&D, manufacturing and marketing technologies towards product development technologies which dominate the present portfolio of “key technologies”. Another current development of the Technology Pyramid is the ongoing development of a database aiming at storing all relevant information concerning the “key technologies” for ease of access and comprehensiveness for the users of the Technology Pyramid.

All employees of Danfoss are allowed to suggest new “key technologies”, but the decision to include a technology in the Technology Pyramid is dependent upon approval by one of Danfoss’ seven cross-divisional committees (cf. section 3.3) to ensure that the technology has a wide variety of application prospects in Danfoss. The committees review the content of the Technology Pyramid, and one or two members from each committee are appointed to form a technical advisory group responsible for the practical work and decisions concerning the Technology Pyramid. The committee responsible for a “key technology” appoints one to five gatekeepers who are responsible for the actual development and monitoring of the relevant technologies, and a sponsor who is responsible for assuring proper linkages and coordination between the committee and the gatekeepers, and for making sure that potential users of the technology are made aware of developments. The gatekeepers do not work full time on their assigned technology but are expected to fulfill their normal duties in the division that employs

²⁷ However, the distribution of the “key disciplines” among the three categories is somewhat ambiguous.

²⁸ The content and names of the “key technologies” evolve as well, which makes it difficult to track individual technologies.

them. The responsible committee can recommend and approve activities beyond what is budgetted in the division employing the gatekeeper.

At the practical level inter-divisional experience groups formed by the gatekeepers promote the improvement and development activities associated with each of the high-priority technologies. The gatekeepers' tasks depend on the characteristics of the technology, which differ widely among the "key technologies". Accordingly, for some technologies, the work of the gatekeeper is application-oriented learning by doing, while for others the primary activities are exchange of experience and networking.

The corporate technology management activities also include the development of tools for analyzing technologies and the maintenance of a directory listing the technological expertise of all Danfoss employees assigned to technology development.

After the closure of CTR these corporate technology management activities were first transferred to the Corporate Planning department, and thereafter, when this department was closed in 1999, to the Quality and Technology department (cf. section 7.1).

8 Conclusion

Since its establishment in 1933 Danfoss has developed from a small tool shop to a global multidivisional corporation with about 20,000 employees, production facilities in 11 countries, sales in more than 100 countries and sales companies in 50 countries. The company today manufactures thousands of different products, particularly mechatronical products for a very diverse set of industrial markets. Scale economies, effective and high-quality manufacturing, and "design for manufacturability" are critical competitive advantages of Danfoss's most important products - certainly of the most successful of them all - the radiator thermostats.

Through its nearly 70 years of existence, a characteristic feature of Danfoss has been diversification. From an initial mechanical engineering base and a focus on the narrow market segment of valves for refrigeration, Danfoss has diversified both with regards to its technology base and its product market scope. The technology base now includes strong capabilities in mechatronics, hydraulics, electronics, software, and stainless steel technology, and the product portfolio comprises thousands of products within 13 broader product lines. The original business niche of valves for refrigeration has expanded into an extensive range of components for all areas of the refrigeration industry. Furthermore, Danfoss has expanded into the broad area of motion controls, including mobile hydraulics and electrical drives and controls for many different indu-

stries. Finally, Danfoss has build up a strong position with a wide range of products within the area of heating and water controls for private homes as well as for industrial buildings. Danfoss has primarily become a multi-product company by pursuing a strategy of related diversification rather than unrelated diversification or vertical integration, even if the two latter also to some extent have been followed, especially in the early history of Danfoss.

During most of Danfoss' existence growth and diversification was primarily generated through internal investments, but during the 1980s and especially the 1990s this pattern has changed in favor of acquisitions of other companies. These acquisitions have primarily been pursued to strengthen market positions and establish sales synergies by offering related or complementary products to existing customers and through Danfoss' existing distribution and sales network.

For a long time Danfoss maintained a policy of having most of the corporate manufacturing activities localized in Denmark (Nordborg). However, by the end of the 1960s this policy was abandoned, partly as a consequence of of the increasing difficulties of attracting sufficient labor to Nordborg, and even if there are still substantial production facilities in Nordborg, Danfoss has today production plants in several other parts of Denmark, as well as in 10 other countries.

As Danfoss has grown due to diversification and internationalization, the corporate organization has undergone several phases of change in the direction of divisionalization and decentralization. The early steps towards divisionalization were taken in 1971, five years after the death of the founder and CEO Mads Clausen. Three "product groups" were established with the objective to build their own development, sales and accounting functions. However, much of the manufacturing and purchasing operations remained centralized, just as the central R&D lab retained responsibility for the longer term R&D efforts. Also a "sales group" was set up with responsibility for direct sales and administration of the sales and service network.

Further steps in the direction of decentralization were taken in the late 1980s when the central purchasing function and parts of the central manufacturing of components were transferred to the product groups (now termed divisions). The sales group was divided into two divisions with responsibility for separate geographic regions. Moreover, the sales subsidiaries became autonomous profit centers, and the divisions were granted the freedom to chose external suppliers.

Again in 1996 and the years after Danfoss underwent substantial reorganization. The number of divisions had grown to 10, and in order to strengthen inter-divisional coordination, the divi-

sions were grouped into three “product families”, Refrigeration Controls, Motion Controls, and Heating and Water Controls. Also the corporate staff functions were subject to change - the corporate R&D lab was closed in order to strengthen the divisions’ responsibility for their own R&D, and the staff and projects were distributed between other corporate departments and some of the divisions. In 1999 a new corporate department has been formed with the exclusive objective to take responsibility for and provide support for corporate venturing projects.

Substantial change also took place in regard to the sales organization and the central manufacturing plants. The two regional sales divisions were dismantled, and instead the product lines (within the divisions) assumed responsibility for their own sales activities, and the sales subsidiaries were to report directly to the product lines. A new small sales unit, the Market Development division, was set up with the objectives: a) to market products in geographic areas too small for the product lines to establish sales offices, and b) to fill gaps in Danfoss’ product range and coordinate collaboration among product lines. Finally, the control and ownership of the central manufacturing plants were transferred to divisional level. As a result, the product divisions now share ownership of the plants, and each of the plants is typically controlled by the division that represent the largest internal customer for the respective plant. The plants are operated as profit centers, and it is acknowledged that the plants supply both internal and external customers.

The attempts to exploit "synergistic economies" through some degree of central coordination and inter-divisional cooperation have been significant even if decentralization has also implied tendencies for divisional autonomy and corporate fragmentation. This is particularly the case in regard to sales and manufacturing activities. As both the range of products and regional markets have expanded, cross-product and cross-regional sales synergies are difficult to obtain in a cost-efficient way. The organization of manufacturing activities has been radically transformed in the wake of ongoing divisionalization, internationalization and company take-overs. While most of Danfoss’ manufacturing activities were centrally coordinated and located in Nordborg, the increasing number of manufacturing plants have spread across the 10 product divisions and across 11 countries. In addition, the corporate R&D activities have gradually been spread throughout the corporation, within each of the divisions and many of the business units and companies abroad. In the dynamic context in which the product divisions have grown larger, increasingly autonomous, and have built their own R&D functions, there is no doubt that the

technology management efforts, especially those linked to the Technology Pyramid and other inter-divisional networking activities, have exerted some overall “guiding” influence on the increasingly dispersed technology base. Not a top-down guidance, but a guidance based on interaction and consensus-building. Moreover, these measures have stimulated horizontal technology exchange, although specific incentive mechanisms have not been implemented to assure this. Altogether technology management has exerted a coherence-promoting influence countervailing the centrifugal forces from the relatively self-contained divisions. It is also likely that the increasing focus on job-rotation of managers as well as the cross-divisional committees and networks have played a similar role of promoting coherence - or at least – to some extent countervailing the inherent tendencies of fragmentation that are associated with ongoing diversification, internationalization and decentralization/divisionalization.

The future strategic challenge to the executive committee and corporate functions is to decide on how to manage the continued growth and differentiation of the corporation. The last thirty years tells the story of successive attempts at solving the conundrum of exploiting synergies from technological, manufacturing and marketing relatedness while maintaining a high degree of accountability at product line level. For this, there are no definite answers, which is why we need to study successful organizations such as Danfoss to inform theory development. This case shows that it is a complex task where changing internal and external circumstances may make attempts at solving the conundrum obsolete before they are fully implemented.

Bibliography

(Most sources written in Danish)

Annual Reports 1980-1997

Boje, Per og Hans Chr. Johansen: "En iværksætter - Historien om Mads Clausen og Danfoss" Odense Universitetsforlag, 1994 (in Danish, primary source of historical information)

Berlingske Tidende 4. Feb. 1996: "Det skal være trygt at være fleksibel" (Danish newspaper article)

Børsen 2. Feb. 1996: "Familieskab intet handicap" (Danish newspaper article)

Børsen 18. Jan. 1999: "Danfoss køber op i Island" (Danish newspaper article)

Børsens nyhedsmagasin No. 20/ 3. Dec. 1993: "Sådan vil jeg køre Danfoss" (Danish business journal)

Børsens nyhedsmagasin *Guldnummeret*, November 1998: 10-21: "Danfoss junior" (Danish business journal)

Børsens nyhedsmagasin *Guldnummeret*, May 1999: "Diamanten Danfoss" (Danish business journal)

Danfoss' internet homepage

Danfoss avisen, various issues (the information magazine for Danfoss employees)

Hansen, Hanne Steen: "Danfoss - Arven fra Mads", J. H. Schultz Information A/S, 1994

Historien om VLT gennem 25 år, Anniversary booklet, Danfoss, Transmissionsdivisionen, 1993

Internal Danfoss-documents (not listed upon request from Danfoss)

Jyllands Posten 17. Aug. 1994: "Ny division i Danfoss" (Danish newspaper article)

PLS Consult: "Beskæftigelsesmuligheder i Danfoss A/S" i "Beskæftigelsesmuligheder for kortuddannede: Seks virksomhedsstudier", Bilag 3 fra "Sekretariatet for Kommissionen om fremtidens beskæftigelses- og erhvervs muligheder", Erhvervsministeriet, 1995, s.21-38 (Government report)

Radiator Thermostats through 50 Years, Anniversary booklet, Danfoss, 1993

Valentin, Finn, Poul Andersen, Bent Dalum, Torben Pedersen og Gert Villumsen: "Strategiske virksomhedsrelationer" Bilag 5 til Kommissionen om fremtidens beskæftigelses- og erhvervs muligheder, Erhvervsministeriet, 1995 (Government report)

Appendix A: Milestones

1997 - A new Sales Organisation structure based on regionalisation is announced. *New factories in Poland and Ukraine. * Acquisitions: Danfoss Esco, Norway, and RICO Group, South Africa. * Strategic alliance between Danfoss Drives and Brook Hansen, Great Britain. * Danfoss Drives takes over 50% of shares in EURO-TEC, Germany. * Danfoss Drives A/S gains the EMAS registration.

1996 - Danfoss issues its first environmental account. * Henry Petersen retires and is succeeded by Jørgen M. Clausen as President and CEO. * Danfoss Drives gains environmental certification (BS 7750). * Agreement on European Information & Consulting Forum. * Acquisitions: Nielsen Hydraulic Services, , Australia; Pilmet S.A. (hydraulics factory), Poland; Danvalve, Denmark, and OREG Group, France. * Factory established in Tianjin, China.

1995 - Acquisitions: Concordia Fluidtechnik, Stuttgart and Hausham, Germany; Trata, Ljubljana, Slovenia; W.F.Refrigeration & W.F.Airconditioning, Great Britain; Climatic, Turin, Italy; Graham Company, Milwaukee, Wisconsin; Danfoss Compressors, Monterrey, Mexico; Nordisk Marine Hydraulik, Næstved, Denmark, and Videk, Rochester, New York. * Textbook on Water Hydraulics. * Turnover: 11,000 mio DKK, number of employees: 17,000.

1994 - Acquisitions: Sordella e Oleodinamica Italy, and Transventor AB, Sweden. * Nessie Water Hydraulics. * Factory established in Moscow, Russia.

1993 - Danfoss Fluid Power is established with headquarters in Racine, Wisconsin and factory in Easley, South Carolina. * Production of evaporator thermostats in Slovenia (joint venture). * Acquisition: MANEUROP, Trevoux Cedex, France.

1992 - The Nordborg factories achieves a voluntary Total Environmental Approval.* Step Systems is sold.* Factory is established in Warsaw, Poland. * Acquisitions: SOCLA, Chalon-sur-Saône, France, and Danfoss Compressors, Crnomelj, Slovenia.

1991 - Acquisitions: Randall Electronics, Bedford, Great Britain; Webster, Racine, Wisconsin, and Fluid Power, Easley, South Carolina.

1990 - Acquisitions: EMC, Fort Myers, Florida, and Dukes Fluid Power, St. Charles , Illinois.

1989 - Acquisitions: Forêt Systems, Massachusetts Step Systems, and PROCOS' EMS Division (merged into Danfoss System Controls, Herlev, Denmark).

1988 - Harald Agerley retires and is succeeded by Henry Petersen as President and CEO.

1987 - The Flensburg Factory is announced Headquarters of the Compressor Division. * Danfoss gains an Environmental Award (Environmental Management & Administration)

1986 - Acquisitions: Werner Kuster AG, Switzerland and Russel Armstrong, Australia.

1985 - The turnover exceeds 5,000 mio.DKK

1984 - Acquisitions: Danfoss System Hydraulik, Næstved, Denmark, and Flowmetering Instruments, Stonehouse, Great Britain. * Wage conflict provokes a major strike

1983 - Andreas Jepsen retires and is succeeded as President & CEO by Harald Agerley.

1982 - Acquisition: Hampton Products Inc., Rockford, Illinois (now Danfoss Electronic Drives).

1981 - Acquisition: ITHO bv., Schiedam, Netherlands (distributor since 1939).

1979 - Factory in Silkeborg, Denmark. * Acquisition: Dean & Wood Ltd., London, Great Britain.

1977 - Acquisition: H. Søndergaard Hydraulik A/S, Ganløse, Denmark, (former distributor).

1974 - Factory in Kolding, Denmark. * KAF in Mjölby, Sweden, becomes a subsidiary (sales and production).

1971 - The "Bitten and Mads Clausen Foundation" is established. * The McKinsey Co. introduces a new division-based organisation with three product groups.

1970 - Two new factories in Denmark: Viby and Gråsten.

1969 - The Norwegian distributor becomes a sales subsidiary.

1968 - VLT Frequency Converters marks the breakthrough of electronics.

1966 - Mads Clausen dies at the age of 60. The company continues with Andreas Jepsen as Managing Director and Mrs. Bitten Clausen as Chairman of the Board.

1965 - Mads Clausen's 60th birthday the subject of 160,000 column-mm, i.e. 46 pages, in the national Danish newspapers.

1961 - Liquidity crisis. Danfoss becomes a limited company.* Factories in Tinglev, Denmark, and in Japan are erected. * Licence on production of hydraulic components from Char-Lynn, USA.

1956 - The first factory outside Nordborg is erected in Flensburg, Germany.

1954 - Employee no. 2000, is engaged

1953 - At the same day employee no. 1,000 and no. 1,001 arrives.

1952 - A 5,000 m² permanent factory building is inaugurated. * Thermostatic radiator valves are launched.

1951 - Licence production of household compressors begins.

1950 - Mads Clausen's USA study tour. * Distributors from 21 countries meet in Nordborg for "The Danfoss Convention".

1949 - The first foreign sales subsidiary is established: Danfoss Argentina in Buenos Aires.

1946 - The company name is changed from "Dansk Køleautomatik & Apparatfabrik" to "Danfoss".

1943 - "The Danfoss Journal" is published. * The product range comprises 37 types of products. *179 employees.

1942 - In Mjölby, Sweden, Svend Hoffmann a friend of Mads Clausen establishes Kontrol Automatik Fabrik AB (KAF), which manufactures Danfoss valves under license.

1939 - The first contract with a foreign distributor: Itho-Schiedam, the Netherlands.

1937 - RT types of thermostats and pressure controls are launched.* Result of an Audit: Mads Clausen is assessed good for a loan of DKK 10,000.

1935 - A second-hand lathe is installed, and during the year the first four employees are hired. * A building of 60 m² is erected.

1933 - Mads Clausen returns to his birthplace to start his own business. Product concept: two automatic refrigeration valves. First year sales: DKK 12,770.

Appendix B: Danfoss' companies

100%-OWNED COMPANIES	100%-OWNED COMPANIES
EUROPE	EUROPE
<p>Austria: Danfoss Gesellschaft m.b.H., Vienna</p>	<p>Spain: Danfoss S.A., Madrid Socla Iberica S.A., Madrid</p>
<p>Belgium: N.V. Danfoss S.A., Brussels Socla Benelux S.P.R.L., Brussels</p>	<p>Sweden: Danfoss AB, Mjölby Kontroll-Automatik Fabriks AB, Mjölby</p>
<p>Bulgaria: Danfoss EOOD, Sofia</p>	<p>Switzerland: Danfoss AG, Frenkendorf Danfoss Holding und Finanz AG, Fribourg Safag Pumpen AG, Biel Werner Kuster AG, Frenkendorf</p>
<p>Croatia: Danfoss d.o.o., Zagreb</p>	<p>The Netherlands: Danfoss bv, Schiedam Itho bv, Schiedam</p>
<p>Czech Republic: Danfoss s.r.o., Prague</p>	<p>Ukraine: Danfoss T.o.v., Kiev</p>
<p>Denmark: Danfoss A/S, Nordborg (parent company) Als Motor A/S, Nordborg Danfoss Drives A/S, Gråsten Danfoss Fluid Power A/S, Nordborg Danfoss Hydraulik A/S, Ganløse Danfoss International A/S, Nordborg Danfoss System Hydraulik A/S, Næstved Danfoss Industrial Refrigeration A/S, Hassel-</p>	<p>Yugoslavia: Danfoss d.o.o., Belgrade</p>
ager	NORTH AMERICA
<p>Estonia: Danfoss AS, Tallinn</p>	<p>Canada: Danfoss Manufacturing Company Ltd., Mississauga, Ontario</p>
<p>Federal Republic of Germany: Danfoss Antriebs- und Regeltechnik GmbH, Offenbach a.M. Danfoss Compressors GmbH, Flensburg Danfoss Industrieautomatik GmbH, Stuttgart Danfoss Interservices GmbH, Offenbach a.M. Danfoss Silicon Power GmbH, Nortorf Danfoss Wärme- und Kältetechnik GmbH,</p>	<p>Mexico: Danfoss Compressors, S.A. de C.V., Monterrey</p>
	<p>U.S.A.: Danfoss Inc., Rockford, Illinois Flomatic Corporation, Glens Falls, New York</p>

<p>Heusenstamm Danfoss-Werk Offenbach GmbH, Offenbach a.M. Oreg Armaturen GmbH, Frankfurt a.M. Socla GmbH, Rheinbach</p> <p>Finland: Oy Danfoss Ab, Espoo</p> <p>France: Danfoss S.a.r.l., Trappes Danfoss Maneurop S.A., Trevoux Oreg S.A., Saint-Alban-Leyse Socla S.a.r.l., Chalon-sur-Saône Sorega S.a.r.l., Annecy</p> <p>Great Britain: Danfoss Flowmetering Limited, Stonehouse Danfoss Holding UK Limited, London Danfoss Limited, Greenford Danfoss Randall Limited, Bedford Dean & Wood Limited, Leatherhead W.F. Air Conditioning Ltd., Leicester W.F. Refrigeration Ltd., Leicester</p> <p>Greece: Danfoss E.P.E., Moschato Attica</p> <p>Hungary: Danfoss Kft., Budapest</p> <p>Ireland: J.J. Sampson & Son Ltd., Dublin</p> <p>Italy: Danfoss S.r.l., Turin Oreg Italia S.r.l., Milan Socla Italia S.r.l., Milan</p> <p>Latvia: SIA Danfoss, Riga</p> <p>Lithuania:</p>	<p>Maneurop Inc., Lawrenceville, Georgia</p> <p>SOUTH AMERICA</p> <p>Argentina: Danfoss S.A., Buenos Aires</p> <p>Brazil: Danfoss do Brasil Indústria e Comércio Ltda., São Paulo</p> <p>Chile: Danfoss Industrias Ltda., Santiago</p> <p>Colombia: Danfoss S.A., Cali</p> <p>Uruguay: Danfoss S.A., Montevideo</p> <p>Venezuela: Danfoss S.A., Valencia</p> <p>AFRICA</p> <p>Namibia: Independent Refrigeration Supplies (Pty.) Ltd., Windhoek</p> <p>South Africa: Danfoss (Pty.) Ltd., Johannesburg Independent Refrigeration Supplies (Pty.) Ltd., Germiston Refrigeration Equipment Company (Pty.) Ltd., Johannesburg Refrigeration Investment (Pty.) Ltd., Johannesburg</p> <p>ASIA</p> <p>China: Danfoss Industries Limited, Hong Kong</p>
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<p>Danfoss UAB, Vilnius</p> <p>Norway: Danfoss AS, Skui, Oslo Danfoss Esco AS, Kongsberg</p> <p>Poland: Danfoss Sp. z o.o., Warsaw</p> <p>Portugal: Danfoss (Portugal) Lda., Carnaxide</p> <p>Romania: Danfoss Rumania S.r.l., Bukarest</p> <p>Slovak Republic: Danfoss Spol. s.r.o., Bratislava</p> <p>Slovenia: Danfoss Compressors d.o.o., Crnomelj</p>	<p>India: Danfoss Industries Private Limited, Chennai</p> <p>Japan: Danfoss K.K., Yokohama</p> <p>Malaysia: Danfoss Industries Sdn Bhd., Selangor Darul Ehsan</p> <p>Philippines: Danfoss Inc., Manila</p> <p>Singapore: Danfoss Industries Pte. Ltd., Singapore</p> <p>AUSTRALIA</p> <p>Australia: Danfoss (Australia) Pty. Ltd., Melbourne</p> <p>New Zealand: Danfoss (New Zealand) Ltd., Auckland</p>
<p>ASSOCIATED COMPANIES</p> <p>The percentages show Danfoss' capital participation in the companies</p> <p>Biterm d.o.o., Bistrica ob Sotli, Slovenia - 25%</p> <p>Viking FC Motors Ltd., Huddersfield, Great Britain - 50%</p>	<p>COMPANIES WITH EXTERNAL SHAREHOLDERS</p> <p>The percentages show Danfoss' capital participation in the companies</p> <p>Danfoss (Thailand) Co. Ltd., Bangkok, Thailand – 49%</p> <p>Danfoss (Tianjin) Limited, Tianjin, China – 75%</p> <p>Danfoss Trata d.d., Ljubljana, Slovenia – 97%</p> <p>ZAO Danfoss, Moscow, Russia –75%</p>