Synergy and organization
The case of Danfoss

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Institut for Industriøkonomi og Virksomhedsstrategi
Working Paper 99-11

Synergy and Organization: The case of Danfoss

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Abstract:
This paper suggest a typology of possible sources of synergies. The paper further proposes that companies cannot exploit all opportunities for synergy because these may require coordination which might add costs that more than offset the advantages gained. The cost of coordination in turn depends on the organizational context, because it affects the way the sources of synergies must be coordinated. These propositions are subsequently illustrated with examples from the Danish company, Danfoss.

Acknowledgments
This paper would not have been possible without the valuable assistance provided by Manager Vibeke Gustafsson and Vice President Hans Jørgen Pedersen, Danfoss, who have contributed significantly to the case material through several interviews and discussions. Helpful suggestions and comments to this paper has been given me by Nicolai J. Foss and Jens Frøslev Christensen. All errors and lack of consistency is, of course, entirely due to my own inadequatecy.

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Introduction

Numerous researchers have suggested that diversity in the assets and activities of diversified firms may be exploited to achieve benefits, often referred to as synergies, by sharing of activities subject to size economies (economies of scale/scope) or by performing mutually adjusted (complementary) activities.

There are a number of reasons for the existence of vertically and horizontally integrated firms. Adam Smith argued that the degree of division of labor is limited by the extent of the market. If demand is insufficient to obtain maximum scale efficiency in certain activities and market imperfections prevent selling excess capacity to external customers, then scale efficient activities provide a rationale for sharing capacity among different lines of business internally (Teece, 1982). The internal workings of firms may also create pressure for growth in the range and size of activities performed. As explained by Edith Penrose (1959), indivisibilities lead to organic growth because increasing the degree of capacity utilization of existing assets through sharing between different uses lead to the acquisition of complementary or supporting resources. These new assets will also be indivisible to some degree, thus leading to continued pressure to expand the size of the corporation to avoid idleness of resources. Dedication of activities to other, complementary, activities also lead to expansion of the firm because dedication creates vulnerability to appropriation of rents by trading partners (Williamson, 1985). For these reasons, firms tend to become diversified in terms of activities and markets served.

The purpose of this paper is to propose how different kinds of synergies can be obtained from this diversity. The paper takes the perspective of corporate management in addressing this issue. The paper is structured into four parts. The first part deals with the identification of potential synergies. The second discusses different forms of coordination and their associated costs. In the third part, that discussion is linked to the sources of synergies identified in the first part by relating the coordination requirements of the sources of synergy to the characteristics of the different coordination mechanisms discussed in the second part. The

fourth part illustrates the discussion with examples of coordination of synergies found in the Danish company, Danfoss. The implications of the illustrations are discussed in a concluding remarks section.

Sources of Synergy

Synergies may be obtained by sharing assets between business units if production based on these assets are subject to declining average unit cost, that is if economies of scale or scope can be obtained. One source of size economies is equipment dedicated to a particular task, which allows this task to be performed with greater efficiency than with generic or non-specific equipment (Montgomery and Wernerfelt, 1988). Increased division of labor and specialization of tasks allows subsets of activities to be performed with greater efficiency by reducing the costs of setting up and changing tasks, and by accumulating more experience and knowledge of the particular task. Dedicated equipment and specialized tasks are only efficient when the services they produce are required in high volumes because dedication and specialization comes with a loss of flexibility that reduce the value in alternative use. Thus dedication and specialization create indivisible capacity. Sharing can reduce the loss from idleness of indivisible assets by increasing the degree of capacity utilization. Finally, increasing the dimensions of physical objects (e.g. buildings) may be less costly than multiplying similar, but smaller ones to reach a sufficient scale (Langlois, 1997).

Efficiency gains can also be achieved by adapting different assets or activities to a common purpose by making them mutually supportive and eliminate waste from reworking of outputs (Porter, 1996). Complementarity can be achieved in a succession of activities where different steps in a chain are adjusted to the preceding and/or proceeding steps for example in the timing of transfer (e.g. JIT), or by improving the interface between activities (making the output fit the input requirements, and/or changing the input requirements to fit the output (Porter, 1985)). Likewise, by adapting to existing resources, new assets can be made more efficient and new opportunities can be exploited faster than if the complementary assets had to be acquired as well. The effects of obtaining complementarity be-

tween activities performed in succession will be referred to as vertical complementarities, which can also be obtained at higher (strategic) levels, for example by accompanying product line proliferation, or increased rate of product development, with flexible manufacturing systems and increased customer segmentation (Milgrom and Roberts, 1990). Complementarities achieved by combining assets or activities to perform a single task can similarly be called horizontal complementarities. Horizontal complementarities may be achieved by adapting parallel activities to each other to increase the value of combining the outputs at a later stage, for example by making intermediate products that fit together when assembled (Whitney, 1988), or by enhancing the combined functionality of bundled products to customers (Spiller and Zelner, 1997).

Three fundamental sources of synergy can thus be identified leading to proposition 1:

> *Synergy can be obtained by:*
>
> *1. Sharing indivisible assets whose acquisition cost are amortized over multiple uses.*
>
> *2.Optimizing the flow of activities (Vertical complementarities).*
>
> *3. Combining the outputs of mutually adjusted activities to achieve superior functionality of the combined output (Horizontal complementarities).*

These different sources of synergy require different forms of coordination if asset sharing pose coordination problems that are different from the problems of coordinating mutual adaptation. The costs of coordination may, however, lead to dis-synergy because the resources spent on coordination more than offset the gains in efficiency. Lack of proper coordination may also prevent the realization of synergies because no sharing or complementarity is achieved. Likewise, loss of accountability caused by corporate management intervention in the affairs of independent business units may add costs to synergy exploitation that more than offset the benefits. Different forms of coordination may result in different levels of direct coordination costs and different degrees of loss of accountability. From this proposition 2 can be developed:

Net synergy is only derived from particular instances of the sources of synergy described above, namely those for which the benefits exceeds the direct and indirect costs of coordination.

Forms and Costs of Coordination

The need for coordination arise when the outcome of one activity depends on how, or when, another activity is performed. In self-sufficient (closed) systems activities are coordinated within the system itself, but specialization among systems (for example firms or business units within a firm) require the systems to engage in exchanges with other systems whose action they cannot control directly. Thus the need for some form of exterior coordination arises. Among firms coordination is achieved through autonomous adaptation to signals in the form of prices and in the form of more or less comprehensive contracts stipulating the terms of exchange and cooperation. Market coordination may become too costly if trading partners are mutually dependent because insuring against opportunistic behavior from either party is impossible unless all future contingencies are known, which is unlikely because people have limited information processing abilities (Williamson, 1985). Organizing dependent activities within a firm put a limit on opportunistic behavior because disputes are settled by fiat (Williamson, 1985). Inside firms a number of coordination mechanisms are available ranging from market-like transfer prices to hierarchical ordering through planning and direction, to team-like continuous mutual adjustment. These polar cases have different properties with respect to incentive effects and use of resources, and thus to the cost and efficiency of coordination.

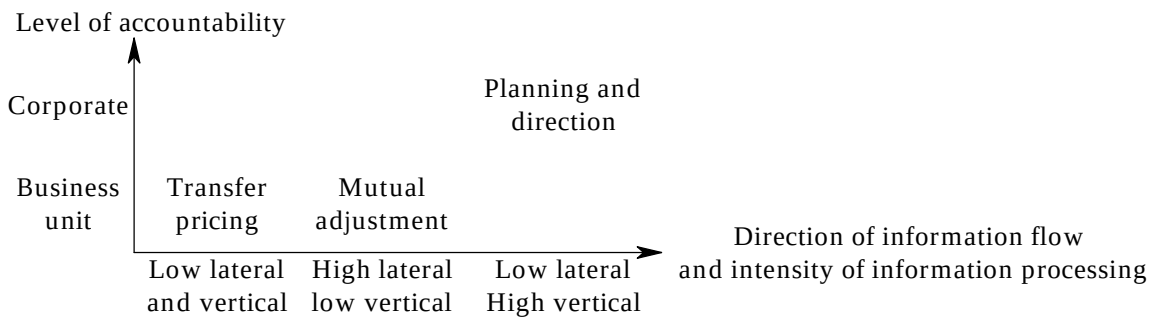
Coordinating through transfer prices and mutual adjustment maintain a large degree of accountability (i.e. relatively strong incentives) at the business unit level which is difficult to uphold when hierarchical ordering is involved. Centralized planning remove responsibility from business unit level to corporate level, and thus diminish the strength of incentives.

The amount of resources consumed by coordinating activities depends on the type and amount of information that needs to be processed and transmitted. Once transfer prices have been set, they require little additional information to be

collected and transmitted. Resources will of course have to be spend on determining the type of transfer pricing rule (e.g. cost-based, negotiated, market based or strategic) and settling the terms, but once established, companies tend to stick to a single transfer pricing rule (Eccles, 1985). The information that has to be transmitted both laterally and vertically is quantifiable (financial and quantities) and therefore easy to communicate. Transfer pricing also allow standardization of information into financial terms making it easily comparable across time and business units. Transfer pricing thus consume few resources in coordinating activities.

Mutual adjustment between business units requires more intensive lateral communication to discover the needs and expectations of the partner, which in case of changes in the circumstances of the cooperation or uncertainty have to continue as long as the exchange continues. The information exchanged laterally is unlikely solely to be quantitative, because then transfer pricing would suffice. Vertical communication, however, can be in financial terms since actual coordination is performed by the directly affected / involved parties. Mutual adjustment, thus, poses information processing requirements at the corporate level similar to those of transfer pricing.

Planning and direction require less lateral information transfer than mutual adjustment because quantitative and qualitative information is transmitted to a hierarchical superior who decides on the appropriate action of the units based on the information received (Arrow, 1974, Radner, 1992). This means that extensive and heterogeneous information has to be processed at the corporate level and thus consumes considerable amounts of corporate resources.



Economizing on costs of weakened incentives due to corporate level intervention and resources spend on transmitting and processing knowledge requires that the more expensive ones (mutual adjustment and planning) are reserved for the transactions that require them. Mutual adjustment is less costly than planning because accountability is maintained at business unit level, and consume less of scarce corporate management resources because information is quantitative[1]. Mutual adjustment may also incur less distortion of information because information is transmitted directly to those with operating responsibility instead of going through a higher hierarchical layer.

Selection of coordination mechanisms

Sacrificing incentive intensity is necessary when strong incentives lead to sub-goal pursuit at the expense of overall performance. High levels of interdependence between business units obscure individual contributions to a cooperative venture, and thus make it very costly to reach an agreement on a distribution of rents that is perceived to be fair by all parties. Differences in actual or perceived interdependence of partners may also create conflict because the one experiencing the least amount of interdependence will be less committed to continue the relationship and may hold up their partner for a larger proportion of the rent generated (McGann and Ferry, 1979). If conflict between business units arise, intervention from the corporate level may be required. Since contributions may be obscured in the case of high interdependence, quantitative and financial information is inadequate to settle conflicts over distribution of gains, which means that conflict settlement requires transmission and processing of qualitative information to and by corporate management.

Corporate management does not have to receive and process qualitative information in the absence of conflict, but high levels of interdependence still require extensive communication between business units in order to coordinate activities because changes in one unit affect the outcome of another. Standardized information on quantities and costs will not convey knowledge of the effect of

[1] Assuming that corporate management resources are more valuable and thus have higher opportunity

changes in one unit on another and may also be received too late to prevent destruction of value if they are only calculated periodically. Qualitative information on planned changes and feedback on the effect on other activities therefore have to be communicated between the concerned parties for gains to materialize.

Thus the levels of interdependence and conflict has to be considered when selecting a coordination mechanism for an exchange. Thus we have proposition 3:

> *The choice of coordination mechanism depends on the level of interdependence and conflict[2]:*
>
> - *Transfer pricing is the least costly coordination mechanism. Transfer pricing is appropriate when the levels of interdependence and conflict are low.*
> - *Mutual adjustment is more costly than transfer pricing, but less costly than planning and direction. Mutual adjustment is appropriate when the level of interdependence is high and the level of conflict is low.*
> - *Planning and direction is the most expensive form of coordination. Planning and direction is appropriate when the levels of interdependence and conflict are high.*

Different ways of ascertaining the level of interdependence has been proposed, for example based on the pattern of the resource flow between business units (Thompson, 1967, Van de Ven, Delbecq and Koenig, 1976), the volume and significance of the exchange[3] (McGann and Ferry, 1979), or the extent to which a business unit's outcome is determined by activities performed in other units (Kelley and Thibaut, 1978, Victor and Blackburn, 1987). The latter two approaches require data on specific relationships, whereas the first is concerned with the nature of the relationship, which is of primary interest in this paper. Since outcomes are determined by the type of coordination mechanism and not given, using outcomes to determine the level of conflict associated whit each source of synergy is

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costs.

[2] In case of low interdependence between units, high levels of conflict does not affect outcomes. This instance is therefore not considered.

[3] Transactional interdependence is increased the greater the number of different assets exchanged, the greater the amount of resource exchanged pr. unit of time, and the number of transactions pr. unit of time. The shorter amount of time before cessation of relationship significantly affect outcome, the greater interdependence will be. Higher value of the resource also increase interdependence. The value of a resource depends on the cost of substituting the resource, the cost of locating other supplier, the qualitative importance of resource for outcomes, and the duration of relationship. The direction of resource flow also affect interdependence (McGann and Ferry, 1979). Thus the receiver of a resource may perceive another degree of interdependence than the supplier. Assets going back and forth between business units increase interdependence compared to exchanges where one type of assets is traded for another.

not possible, even though outcomes allows the level of conflict to be determined directly from the outcomes[4] (cf. Kelley and Thibaut, 1978, Victor and Blackburn, 1987).

Thompson (1967) describes three types of interdependence named pooled, sequential and reciprocal interdependence. Pooled interdependence exists when all units make discrete contributions to the whole and is supported by the whole without either being directly dependent. When the asset shared among units is drawn from a common pool of assets, asset sharing leads to pooled interdependence, which Thompson considers to be the lowest level of interdependence in an organization. Asset sharing should therefore be compatible with transfer pricing coordination according to proposition 3.

If two business units are engaged in a relationship, where one unit has to perform its activity before the other is able to perform its activity, the business units are sequentially interdependent. This is the case of vertical complementarities, because R&D precedes production, which in turn precedes sales and marketing, at least in the usual perception of these general business processes. Vertical complementarities should thus exhibit higher levels of interdependence than asset sharing because the level of interdependence is higher for sequential interdependencies than for pooled interdependencies (Thompson, 1967). Even higher levels of interdependence (reciprocal) is incurred if both business units are affected by the concurrent actions of the other business unit. Horizontal complementarities im-

[4] Neither the pattern of resource flow nor the volume and significance of the exchange does assess the potential for conflict directly because the congruence or non-congruence between objectives is not considered. Determining interdependence from outcomes, on the other hand, allows the level of conflict to be determined as well by allowing both negative and positive outcomes (Victor and Blackburn, 1987). However, this requires that outcomes are known, and thus it could be argued that conflicts could be mitigated by a fair profit sharing scheme between units. Changing the reward system to award each unit fairly for cooperating may be disruptive to the general guidelines and therefore too costly if the cooperation only affects a minor part of the units' activities. Settling the conflict over distribution of rents through bilateral bargaining may also prove too costly to allow rents to be captured if bargaining costs exceed the efficiency gain from cooperating. The level of interdependence for a unit can be ascertained by calculating the ratio of the sum of outcomes (squared) contingent on the actions of other units to the sum of all outcomes (i.e. unit A's dependence on other units = outcomes influenced by other units^2 / all possible outcomes^2). Likewise, the level of conflict can be calculated as twice the sum of the products of unit A's outcome and the product of other units outcome divided by the squared outcomes of both unit A and other units (i.e. level of conflict = 2(unit A's outcomes influenced by other units * unit A's outcomes independent of other units + other units' outcomes influenced by unit A* other units' outcomes independent of unit A) / ($\sum$(all outcomes)^2) (Formulas derived from Victor and Blackburn, 1987).

plies parallel activities contributing to a common outcome and will, thus, be more (reciprocally) interdependent than asset sharing and vertical complementarities.

The symmetrical dependence present in reciprocal interdependencies dampen manifest conflict because each party can threaten to withdraw from co-operation, whereas the asymmetrical dependence present in sequential interdependencies allows the independent business unit to hold up the dependent one. Thus the level of conflict is assumed to be higher when sequential interdependence is present than in case of reciprocal interdependence. In other words, vertical complementarities, being sequential interdependencies, are associated with high levels of conflict and a significant degree of interdependence, and should thus, according to proposition 3, be coordinated through planning and direction. Likewise, horizontal complementarities should exhibit low levels of conflict, because dependence is symmetrical, and high levels of interdependence. Mutual adjustment should, thus, be the appropriate coordination mechanism for horizontal complementarities. This leads to proposition 4:

- *Asset sharing should be coordinated through transfer prices.*
- *Vertical complementarities should be coordinated through planning and direction.*
- *Horizontal complementarities should be coordinated through mutual adjustment.*

However, the exploitation of synergy sources are not independent of other activities and exchanges which also require coordination. When the control system is designed with multiple coordination mechanisms, or the control system is affected by other control systems designed for controlling other activities, interaction effects will arise that can either reinforce or undermine the intended effect of the control system. If the outcome of different tasks undertaken by an agent are not equally easy to measure, attention will be diverted towards the tasks that are easiest to measure (Thompson, 1967, Holmstrom and Milgrom, 1991). Even

though multiple coordination mechanisms are feasible[5], companies should therefore choose a limited number to avoid unforeseen interaction effects and confusion.

The structure of the organization (e.g. the boundaries of business units) determines whether a given source of synergy is exploited within a business unit or through cooperation between business units. Thus, in a functionally organized corporation (also referred to as U-form or purpose departmentation) horizontal complementarities and asset sharing occur within business units because organizational boundaries are drawn around similar activities (e.g. R&D, manufacturing, marketing / sales), whereas divisionalized firms (also referred to as M-form or process departmentation) set boundaries around vertical relationships which makes vertical complementarities within-unit activities because R&D, production and marketing / sales are located within the same business unit.

Due to the complexities of coordinating multiple interdivisional interdependencies, bounded rationality will limit the ability to foresee the effects of changes in, or additions to, the control systems, wherefore unintended side effects might appear. Management therefore have to go through a process of trial and error before an appropriate control system is in place[6]. Furthermore, the design of a control system is not a complete indicator of the coordination effect achieved by the system, since control systems can be implemented in different ways (Rotch, 1993). Companies with established control systems that works satisfactorily will therefore resist frequent changes in the control system out of fear for unintended effects. Changes in the control system will not take place unless major changes in the composition of activities has occurred. Consistency over time in the way performance is monitored and rewarded is important for the behavior adjusting effects of the control system since frequent changes may make managers uncertain

[5] Application of one form of coordination does not preclude the use others at the same time (Van de Ven et al., 1976). In fact, managers do employ multiple coordination mechanism to supplement each other for a given task and to control multiple tasks (ibid). Van de Ven, Delbecq and Koenig (1976) also found that increasing interdependence leads to the addition of supplementary coordination mechanisms rather than to substitution of certain types of coordination mechanisms.

[6] An optimal control system is unlikely, since companies are open systems subject to influence from the dynamics of the environment affecting the composition of tasks, even if one of the rationales of business

about the consequences of their actions for their personal remuneration and thus distort incentives. History and economic significance of activities may thus be important criteria in designing control systems, which means that new and/or less important coordination tasks will receive only ad hoc attention and coordination.

Coordination of the different sources of synergy is not independent of other activities taking place in the company. Nor will exploitation of all possible synergies necessarily be the primary objective of a company, which means that some sources of synergy will be exploited, while others will be ignored or unrealized. This implies that synergies are company specific depending on the composition of the asset stock, the scope of activities and the design of the overall control system[7]. Because of this contextual dependence the appropriate coordination of different sources of synergy is firm specific, which leads us to proposition 5:

> *The choice of coordination mechanism not only depends on the level of interdependence and conflict created by the activity, but also on other contextual factors including organizational structure and experimentation due to bounded rationality preventing optimal design of control systems.*

In the next sections I provide a few illustrations collected from a study of a successful Danish manufacturing company, Danfoss[8].

Coordination of synergies at Danfoss

Since its establishment in 1933 Danfoss has been one of the most successful Danish manufacturing companies. Every single year since 1933 Danfoss has shown a positive profit. Danfoss is Denmark's largest industrial group with an annual turnover of 15 billion DKK. and with about 20,000 employees. The company manufactures thousands of different products and product models within 14 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-

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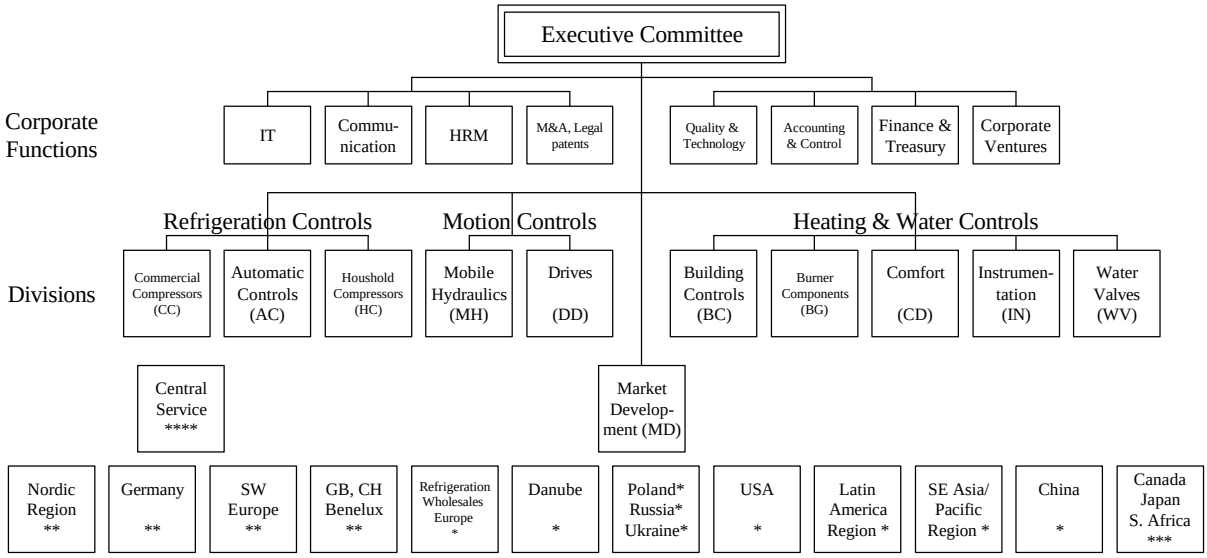
organizations is to protect the operating core from environmental uncertainty and change (cf. Thompson, 1967).

[7] This adds to the sustainability of the advantages gained from synergies because protection from imitation is offered not only from evolving heterogeneity of resources and activities, but also from the consequent heterogeneity of control systems among firms.

[8] The examples are based on a case study of Danfoss conducted over three years (January 1996 to January 1999) by the author and Jens Frøslev Christensen (unpublished)

conditioning automatics, hydraulic components and industrial instrumentation (e.g. electronic flow meters). The company is divisionalized with ten product divisions grouped into three "product families" acting as boards for the product family's product divisions[9].

Figure 1: Danfoss' organization-structure winter 1998/99



**** Owned by the divisions
Regional Sales: * Reports to the board ** Regional reporting to Divisions *** Reports to MD

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).

The relatedness in terms of technologies and markets provide rich opportunities for synergies of different kinds. Danfoss has, however, followed a path of increasing decentralization and delegation concurrent with considerable growth in the last three decades. Thus, from the death of the founder in 1966, and markedly in the last decade, emphasis has shifted from centralized coordination to delegation of operating and financial responsibility to the product line level.

[9] In 1999, Danfoss has acquired a german company (effective from June 1.), Bauer Antriebstechnik GmbH, which will become the eleventh division in Danfoss and be part of Motion Controls product family. Bauer develops, produces and sells electric motors, gears, and gear motors, some of which can be integrated with the products of the Drives Division.

The following examples from Danfoss try to show how the emphasis on, and co-ordination of, different sources of synergy has evolved over the past thirty years.

General description of the corporate control system at Danfoss

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 “Mergers & Acquisitions, Legal Affairs and Patents” assists in negotiations and analysis when a division wishes 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 have 12 councils called “Technical Advisory Groups” (TAG’s) overseeing Construction, Quality Assurance, Production Equipment and Logistics, Sales / Marketing, Purchasing, IT, 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 Danfoss’ 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.

Among the corporate management’s control- and coordination mechanisms are so-called “perspective plans”. The perspective plans contain information on each division’s plans for the coming three years, and explanations for de-

viations 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 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 suggest possible changes.

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 specific projects to divisional management, but divisions are not obliged to accept the proposals.

Asset sharing

Sharing of intangible assets

Despite increasing emphasis on market orientation, Danfoss remains a technology-driven company relying on technological superiority in most of its products and processes. The ability to share R&D costs among multiple product lines therefore remains an important opportunity for gaining cost and differentiation advantages compared to less diversified, or more unrelated diversified, competitors.

Until 1971, Danfoss was a functionally organized company with a centralized R&D function serving all product areas. In 1971, Danfoss initiated a process of divisionalization because of increased complexity in managing an expanding product portfolio, consisting of, at that time, more than 300 different products. In the process of divisionalization, three divisions with separate R&D departments were established. Because many technologies were still common to more than one division, a corporate function for technology and research (CTR) was retained at the corporate in order to serve the common interest of all divisions.

As the product portfolio and the number of divisions continued to expand up through the 1970's, 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 tendency was reversed in the 1980's under new leadership, when the CTR regained significant autonomy. CTR instead began focusing on fewer, more strategic R&D projects leading to the creation of a number of new business ventures rather than upgrading the technological capabilities of the divisions. Thus, the role of CTR changed from developing technologies in common to several divisions aimed at avoiding duplication of effort and amortizing development costs, to a role of providing corporate renewal through development of new business ventures.

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 prompted by the executive committee, which was anxious about the effect of the increasing decentralization on the overall coherence of the corporation. Over the next couple of years a new tool called the "technology pyramid" was developed with the aim of contributing to the creation and diffusion of technological capabilities. The "technology pyramid" was developed in participation of heads of development, manufacturing and marketing from the divisions along with substantial involvement from the executive committee. In late 1991, the responsibility for the "technology pyramid" was assigned to the CTR, which added a new role to the department.

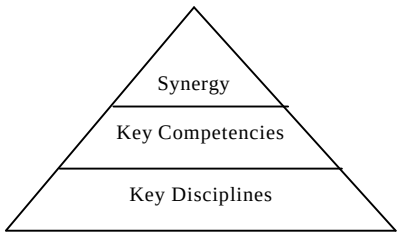
The technology pyramid contains a selection of technologies in which Danfoss can (or want to) claim world-class expertise. These technologies have significant value for more than one division[10]. The technology pyramid is not static but regularly subject to consideration and changes, especially regarding the technologies under consideration.

[10] For technologies that are only important to one division, the interested division in question is expected to take full responsibility

"Synergy" was situated as the top of the technology pyramid in 1996, reflecting the overall ambition and common denominator of the technology pyramid[11]. 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 1: Danfoss' Technology-pyramid until 1996



At the next level in the pyramid were seven key competencies defined as those capabilities where Danfoss wished to achieve global leadership. Four competencies were 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 their 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 focus on five to eight of them at a time.

The lowest level of the technology pyramid was Danfoss' key disciplines, which were capabilities that Danfoss wanted to master on a level equal to the best of its competitors. In 1996, several of the initially 29 disciplines had been replaced, either because their development was considered complete (five key disciplines were considered well-established), or because they had failed to show the anticipated potential (nine key disciplines were kept under observation). Additional key disciplines had been introduced which brought the number of key disciplines

[11] By 1996, synergy had 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.

up to 20 in 1996. Eight of the key disciplines were related to product technology, seven were related to process technology, and five to marketing and management[12].

Since 1996 the terms key disciplines and key competencies have been replaced by the term key technologies. To focus and strengthen effort in each of the key technologies the 27 key competencies and disciplines were reduced to 12 key technologies[13]. 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 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 to ensure that the technology has a wide variety of applications 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 responsible committee can recommend and approve activities beyond what is budgeted in the division employing the gatekeeper. The gatekeepers do not work full time on their technology but are expected to fulfill their normal duties in the division that employs them. At the practical level inter-divisional experience groups formed by

[12] Distribution of the core disciplines among the three categories is not unequivocal.

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. Thus, for some technologies, the work of the gatekeeper is application-oriented learning by doing, while for others the primary activities are experience exchange and networking.

With the implementation of the "technology pyramid" the CTR took responsibility for providing guidance in the selection and development of new technological capabilities rather than developing the technologies themselves for later dissemination throughout the company. Duplication of effort is reduced and critical mass achieved by establishing and managing a network of competence acquirers and providing a link between the competence acquirers and divisional development teams in need of the technological capabilities.

In the last couple of years, the CTR has been closed down, and its activities divided among different divisions and corporate functions. Many of the regular R&D activities have been transferred to the divisions in order to strengthen their incentives for undertaking R&D and allow greater integration with their business strategies. Short term projects such as consulting or technological extension services has been transferred to a Central Service department owned and operated by the divisions. The Central Service department assists in projects related to standardization, approvals, materials technologies, IT development, production services and man-machine interfaces. These activities are primarily funded by the divisions on hourly rates[14]. The "technology pyramid" is now the responsibility of the corporate function "Quality and Technology"[15], which undertakes projects and activities related to quality management, process development, environment and supply chain management, whereas ongoing business development projects and new ventures have been transferred to a corporate

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[13] The contents and title of the key technologies evolve as well, which makes it difficult to track individual technologies.

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

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

function for business ventures. The patenting unit of CTR has been merged with other legal advisory services and a unit assisting in mergers and acquisitions to form a separate corporate function called M&A, Legal and Patents.

The way sharing of technological assets in Danfoss has been coordinated has thus changed from the centralized planning style until 1971, followed by a decade of a somewhat failed attempt at coordinating through transfer prices (direct divisional funding of an increasing number of individual projects without much coherence). The move back towards central planning of corporate R&D in the 1980's resulted in a decoupling of corporate R&D from the objective of upgrading divisional technological capabilities through shared technology development. This objective appears to be better served through the invention of the technology pyramid which allows the divisions to mutually adjust their common technological development through the networks of committees, sponsors and gatekeepers. The ongoing organizational restructurations has also put increasing emphasis on establishing devices for coordinating sharing of intangible assets belonging to the divisions rather than sharing assets under corporate ownership. Thus the dynamics of technology diversification has changed the way Danfoss organize and coordinates sharing of technological capabilities.

Sharing of tangible assets

Danfoss is a vertically integrated company undertaking a large part of its own component manufacture. Thus with increasing, but related, diversification and divisionalization going on, particularly after 1971, opportunities for shared components manufacture among separate product lines continue to arise. When divisionalization began in 1971, most manufacturing activities were transferred to the newly established divisions, but the manufacturing activities that served several of the divisions continued under the responsibility of the corporate headquarters.

Even when decentralization was taken further in 1988 entailing among other things divisional responsibility for purchasing, corporate headquarters still continued to operate corporate manufacturing plants, although additional production activities have been transferred to the divisions.

Until 1996, internal sourcing was considered strategic, among other things to maintain Danfoss' reputation for high quality products, sustain manufacturing capabilities and secure employment levels, thus putting pressure on the divisions to buy from the corporate plants. Decisions concerning outsourcing of manufacture had to be based on analysis of the suppliers' ability to supply products or components that met the required specifications on time at a cost that was lower than the full cost including cost of capital of internal manufacture. Danfoss also considered whether external sourcing would grant access to new know-how that was of strategic importance to Danfoss, or imply transfer of know how to suppliers that Danfoss wanted to keep proprietary. Suppliers were also evaluated on their willingness to accommodate large fluctuations in demand.

Major reorganizations beginning in 1996 has, however, put more emphasis on financial responsibility, also of the component manufacturing plants. As a result of the reorganization, the manufacturing centers[16] which previously were operated by corporate management, have been transferred to the product divisions, who share ownership of the manufacturing centers. The largest internal customer of each of the manufacturing centers was given the responsibility of overseeing its operations, while the individual manufacturing center operates as an independent profit center supplying both internal and external customers. The manufacturing centers compete with external suppliers for the orders, since there are no mandated transfers. Internal transfers are priced based on a target profit for the center set by its board consisting of representatives from the divisions. Tangible asset sharing in the form of transferring equipment between divisions is based on bilaterally negotiated prices.

Shared component production has thus changed from central planning coordination until 1971 to changing transfer pricing rules with progressively more financial responsibility (from corporate subsidized cost based prices to full cost based prices with corporate pressure for internal sourcing, and then to autonomous profit centers in competition with outside suppliers) and decreasing corpo-

[16] The manufacturing centres manufactures electronics, plastic components, springs etc. The manufacturing centers are all located in Nordborg.

rate intervention. Despite more divisional freedom to source components from external suppliers, the corporate manufacturing centers have grown in size up to approximately 1,000 employees in the last couple of years. Even though growth is partly due to increased sales to external customers, external sales are still modest, implying that significant advantages of shared manufacturing assets are obtained and may have increased with the exposition to competition from external suppliers.

Vertical complementarity

From the early steps toward divisionalization in 1971, product lines and divisions have gradually gained control over increasing parts of their individual value chains. Thus the first three divisions were authorized to build their own sales and development departments. As Danfoss continued to grow, activities have continued to be split up among self contained business units (divisions and product lines) in order to decrease product range heterogeneity within each business unit and thus strengthen market focus. Increasing control over sales and marketing within the business units provides a more direct linkage between development, production and marketing which eases mutual adaptation and monitoring of results because performance is evaluated against customer reactions.

The perhaps most radical change implemented during the major reorganization beginning in 1996 was the reorganization of the sales organization where the two regional sales divisions established in 1988 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 expenses. As of April 1998 the old sales organization has been further decentralized with each of the product lines having full financial responsibility for its own sales. A small residual of the central sales organization has been retained at the corporate level (Market Development Division), while the rest has been transferred to 12 regional sales organizations with separate sub-organizations for each product line. Sales and marketing is now carried out by separate sales organizations for each product line. Sales offices in smaller countries or regions where Danfoss has no local

manufacturing, however, operates as if they were independent sales agents with the right to refuse to market and sell products that are not sufficiently profitable, or renegotiate prices with the supplying product lines.

Reorganization from a functionally organized to a divisionalized and increasingly decentralized company has thus given the product lines more control over both product development, production and sales over the past thirty years. This has increased the opportunities for mutual adjustment among the stages of value creation within each of Danfoss' 14 product lines.

Horizontal complementarity

Even though the continued decentralization has decreased horizontal coordination in the last thirty years, it has remained an important objective for Danfoss to obtain horizontal synergies[17]. Thus the acquisition strategy of Danfoss is to strengthen market positions and, generally, not to acquire critical R&D capabilities. An important element in the strategy for acquiring European companies is to find companies whose products complement those of Danfoss and can be marketed through Danfoss' existing distribution network, although the increased acquisition activity in recent years has included acquisition of direct competitors. The objective of acquiring companies located outside Europe is also to increase capacity of distribution and create credibility in relation to local partners. The acquisition strategy and the corporate function specialized in acquisitions direct divisional acquisitions.

The sales companies were in 1988 allowed to supplement the Danfoss product range with products from external suppliers provided the products met Danfoss quality standards and were not marketed under the Danfoss brand.

During the first half of the 1990's Danfoss tried to promote "cross product line selling", but the limited "cross product line selling" activities that were implemented were not perceived to have been successful, and had, furthermore, contributed to obscure the actual cost of selling individual products. That made corporate management feel that product lines needed more attention to the real

cost of selling, which were considered too high. Thus, there are no specific rewards to sales management and personnel for trying to sell, or learning about, products from other product lines. The product lines do, however, source products and components from each other based on prices settled by negotiation.

One of the objectives of the Market Development division established in 1998 is to contribute to filling the gaps in Danfoss' product range and coordinate collaboration among product lines. This will be done by targeting specific "Strategic Business Areas" (SBA) where products from different product lines can be marketed collectively for a specific application[18]. Thus, instead of having all sales personnel trying to find opportunities for "cross product line selling", creation of horizontal complementarities between related products is now being promoted by the Market Development Division targeting specific "Strategic Business Areas", where the benefits are perceived to be greatest.

Danfoss' ten product divisions were, in 1998, grouped into three "product families", Refrigeration Controls, Motion Controls, and Heating and Water Controls according to the criteria of similarity and common interest. One of the objectives of forming the product families was to increase awareness of gaps in the product ranges between the divisions in the product families, which may lead to identification of new business opportunities. So far 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 joint 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 and technology substitution.

Thus, horizontal complementarities are now coordinated through specialized organizational structures (i.e. product families, Market Development Di-

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[17] In fact, inter-divisional cooperation appears to have increased, especially in the last six years.

[18] 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).

vision and a Mergers and Acquisition Department) facilitating mutual adjustment, instead of providing incentives for “cross product line selling” (i.e. a sort of transfer pricing rule). Mutual adjustment among divisions, which is facilitated by the cross-divisional committees and the formation of the product families has also replaced centralized planning of horizontal complementarities which has been gradually abandoned since 1971.

Concluding remarks

The paper has shown that the typology of synergy is useful for describing synergies in Danfoss, thus confirming proposition 1. Moreover, it seems that it does not pay to pursue all possible sources of synergy, since counterweighing costs and objectives has led Danfoss to forego synergies pursued in the past and renege on pursuing other synergies. This finding supports proposition 2. The trend in Danfoss towards increased emphasis on transfer pricing and mutual adjustment and decreasing direction and planning from the corporate headquarters supports proposition 3. The organization of vertical complementarities within business units (i.e. divisions and product lines) substitutes divisional planning and direction for corporate planning which supports both the proposition that intervention by corporate management is the most expensive coordination mechanism (proposition 3) and the proposition that vertical complementarities needs to be coordinated through planning and direction (proposition 4).

Proposition 4 is also partially supported by the fact that tangible asset sharing is coordinated through transfer pricing, although intangible asset sharing appear to be better coordinated through mutual adjustment. Horizontal complementarities are coordinated through mutual adjustment consistent with proposition 4.

The experiences of Danfoss points to that coordination of synergies is in fact dependent on the overall organizational context and, furthermore, not easily accomplished consistent with proposition 5. Another general observation in Danfoss is a failed process of moving directly from centralized planning to extreme decentralization, which has led the company to establish organizational facilita-

tors for mutual adjustment concurrent with ongoing decentralization. This lends further support to proposition 5.

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