Managing Synergy
The Case of Danfoss

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Managing Synergy: The case of Danfoss

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Abstract:

This paper suggest a typology of possible sources of synergies and relates the different types of synergies to corresponding types of coordination mechanisms. The propositions regarding the relationship between different types of synergy and different coordination mechanisms are illustrated with examples from the Danish company, Danfoss.

Keywords
Synergy, Organization, Coordination, Complementarity, Interdependence

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I: Introduction

The purpose of this paper is to propose how these different kinds of synergies should be coordinated. Economizing on the costs of coordination is important because high cost of coordination due to improper coordination may lead to dis-synergy if 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. Despite the importance of economizing on coordination costs, the issue of how to coordinate different kinds of synergies has received scant attention so far, although a few studies have explored part of the question, for example, how resource sharing affect the efficiency of strong incentives (Gupta and Govindarajan, 1986; Govindarajan and Fisher, 1990) and the relationship between organization structure and synergy (Hill and Hoskisson, 1987; Jones and Hill, 1988). The paper takes the perspective of corporate management in addressing this issue.

The paper is structured into four major parts. The first part (section II) deals with the identification of potential synergies. Section III discusses different forms of coordination and their associated costs. In the third part, section IV, 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. In the fourth part, section V, the discussion is illustrated with examples of coordination of synergies found in the Danish company, Danfoss, which is described briefly in the following[1]. The implications of the illustrations are discussed in a concluding remarks section.

Danfoss has been one of the most successful Danish manufacturing companies since its establishment in 1933. 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 has almost 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-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

[1] The illustrations are drawn frown from a case-study of Danfoss (Iversen and Christensen, 1999).

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.

II: Sources of Synergy

Vertically and horizontally integrated firms exists for a number of reasons. 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. It is generally believed that the diversity in the assets and activities of diversified firms can 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.

A: Asset sharing synergies

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).

In Danfoss asset sharing opportunities include the possibilities of sharing key technologies among products and product lines which allow the company to amortize the costs of acquiring technological capabilities and knowledge. Danfoss also exploit its opportunity to share its brand capital among its businesses as well as its sales efforts in smaller geographical markets. Physical resources are also shared to some extent in Danfoss. Thus some of the components manufacture as well as buildings in foreign locations are shared among product lines when it is deemed efficient. However, due to increasing diversity of the overall activities, asset sharing is generally occurring only among the most related activities and products, while the proportion of assets shared among all product lines has declined with increasing heterogeneity of the demands posed by the product lines.

B: Complementarity

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 between 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).

In Danfoss increasing product differentiation has been accompanied by increasing product line control over both product development, manufacturing and marketing/sales, which has increased opportunities for mutual adaptation among these stages of value creation, as well as more product and product line specific investments in dedicated activities. This change has been brought about by increasing emphasis on specialized products as well as in-

creasing scale of individual product lines which has made it possible for the product lines to achieve efficient scale of operation in most of their activities and thus reduced the need for sharing among activitities.

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).

While Danfoss' product lines have gained increased autonomy due to increased scale and managerial emphasis on financial accountability, corporate management is still trying to promote the exploitation of product complementarities among product lines in the marketing stage through joint sales of products targeted at specific areas of application such as water purification. Danfoss also has an opportunity to create complementarities among some of the technologies involved in creating some of the more complex products by integrating technological capabilities in for example electronics, software and mechanics.

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 fit among sequentially performed 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.

III: 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.

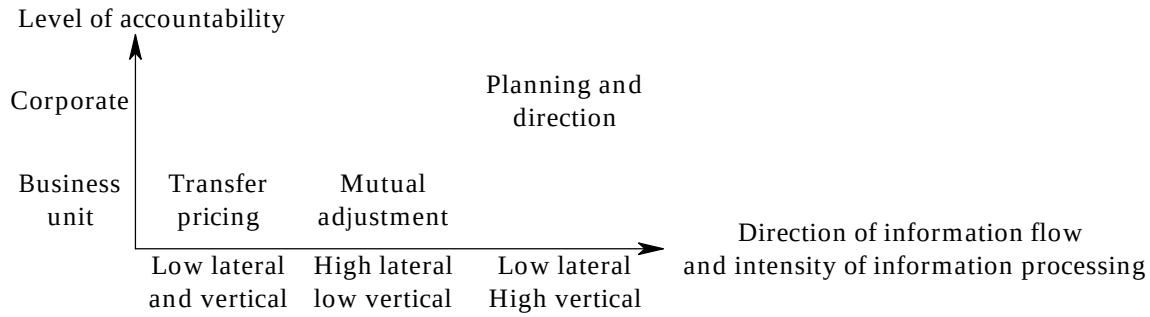
Coordinating through transfer prices and mutual adjustment maintain a large degree of accountability (i.e. relatively strong incentives) at the business unit level which is difficult to uphold when hierarchical ordering is involved. Centralized planning remove responsibility from business unit level 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[1] (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.

Figure 1: Costs of different coordination mechanisms



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[2]. 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.

IV: 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 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 2:

The choice of coordination mechanism depends on the level of interdependence and conflict[3]:

- *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.*

A: Ascertaining the level of interdependence

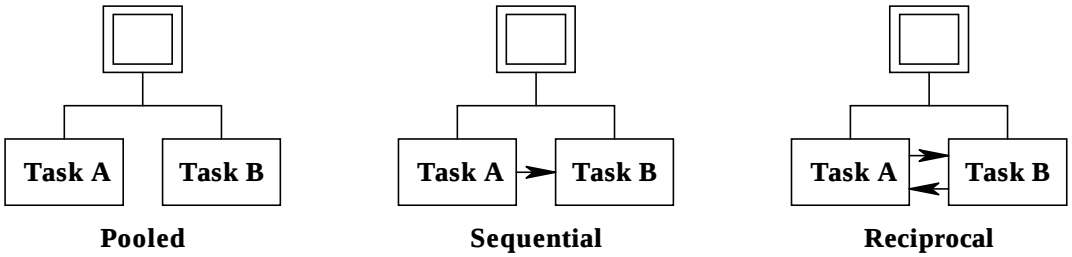
Different ways of ascertaining the level of interdependence have been proposed, for example based on the pattern of the resource flow between different tasks (Thompson, 1967; McGann and Galbraith, 1981; Van de Ven, Delbecq and Koenig, 1976), the volume and significance of the exchange (McGann and Ferry, 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).

Thompson's interdependence construct describes three discrete types of interdependence (pooled, sequential and reciprocal[4] which has become a standard reference, whereas the Kelley and Thibaut / Victor and Blackburn interdependence construct use a continuos (numerical) measure of interdependence which require numerical data on the outcomes of different situations[5]. McGann and Ferry's construct of interdependence is a checklist of factors affecting perceived and real interdependence[6]. The latter two approaches require data on specific relationships to be useful, whereas Thompson's construct is concerned with the nature of a relationship which is more useful with regards to analyzing the organizational requirements of the different, discrete types of synergies.

Thompson (1967: 54) described pooled interdependence as situations where "*each part renders a discrete contribution to the whole and each is supported by the whole*". Pooled interdependence is the lowest level of interdependence in an organization because no unit is directly dependent on another unit. 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. Even higher levels of interdependence (reciprocal) is incurred if both business units are affected by the concurrent actions of the other business unit. The different types of interdependence are illustrated in figure 2.

Figure 2: Different types of interdependence



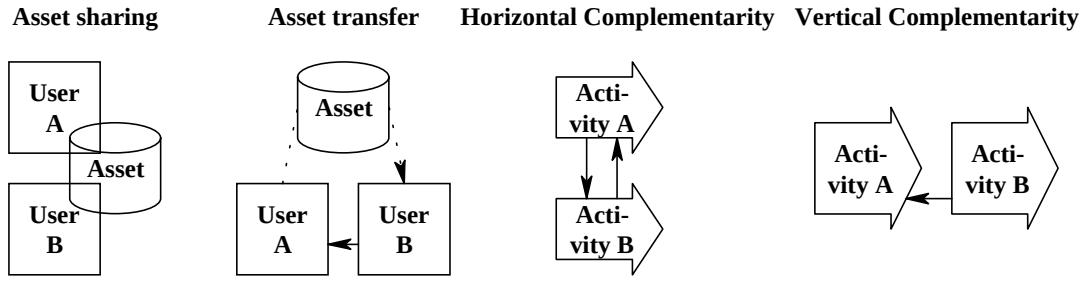
McGann and Galbraith, 1981: 63

B: Interdependence of different kinds of synergies

Vertical complementarities can be described as sequentially dependent because they are obtained between sequential activities such as R&D and production or production and marketing. Horizontal complementarities stem from parallel activities that make inseparable contributions to a common outcome[7], and will, thus, be reciprocally interdependent. The level and nature of interdependence incurred by asset sharing is more complicated to assess, because asset sharing can take different forms and involve different types of relationships. When the shared asset is intangible such as a patent or a corporate trademark, it can be used in multiple applications without congestion or depletion. None of the users of the asset will consequently be affected by the use of the asset by other users[8]. Transfer of intangible assets is similar to sharing of intangible assets because the asset can still be used by the unit from which it was transferred which means that the transferring unit's outcome is not affected by the transfer. Sharing and transfer of intangible asset will thus result in pooled interdependence. Sharing of tangible assets also leads to pooled interdependence when, for example, a shared sales force or a building is used by different units at the same time. However, as noted in chapter 2, asset sharing sometimes coincide with vertical complementarity when the services of the asset serves as an input to other activities. A shared tangible asset such as a production plant manufacturing components for use in different products thus form a sequential relationship between the unit possessing the asset and the users of the outputs and will therefore incur sequential interdependence. Transfer of tangible assets also create a sequential interdependence between the recipient and the former user, since a tangible asset can only be used by one unit at a time. If the transfer of a tangible asset occur infrequently, for example when a machine is transferred from one unit to another, then the units will only be sequentially

interdependent at the time of the transfer, but will otherwise exhibit pooled interdependence.

Figure 3: Interdependency of different synergies



Note: Solid arrows indicate direction of interdependence.

In other words, asset sharing generally creates less interdependence than vertical complementarities, which in turn cause less interdependence than horizontal complementarities.

The symmetrical dependence present in reciprocal interdependencies dampen manifest conflict because each party will incur losses if cooperation is terminated, whereas the asymmetrical dependence present in sequential interdependencies allows the less dependent business unit to hold up the more 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 2, 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 3:

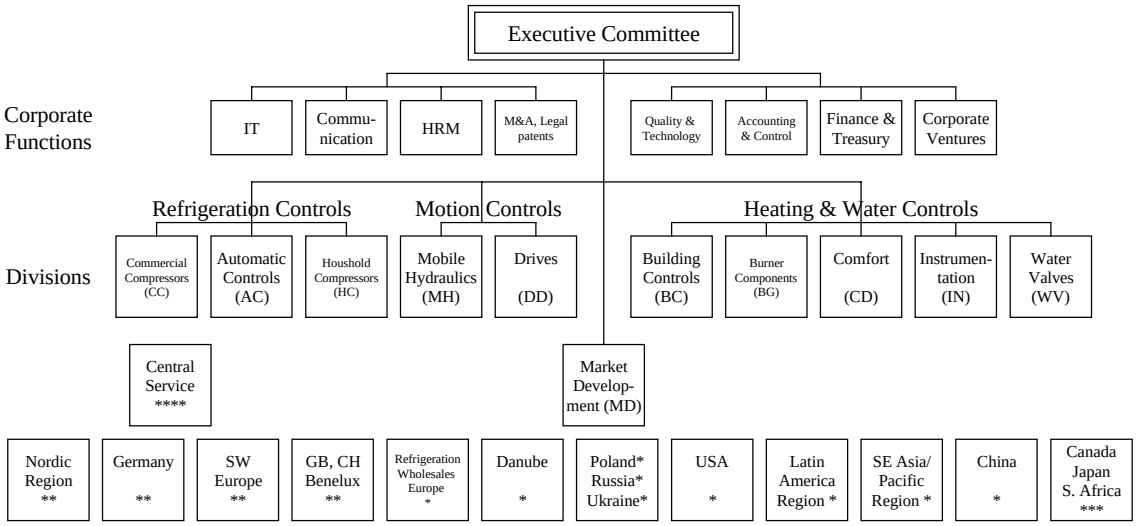
- *Asset sharing should be coordinated through transfer prices.*
- *Vertical complementarities should be coordinated through planning and direction.*
- *Horizontal complementarities should be coordinated through mutual adjustment.*

V: Coordination of synergies at Danfoss

Danfoss is divisionalized with ten product divisions grouped into three "product families" acting as boards for the product family's product divisions[9] (cf. figure 4). Danfoss has 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.

Figure 4: Danfoss' organization-structure winter 1998/99



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

Decision making responsibilities have extensively been delegated to divisional management, even the right to implement, for example, large development projects or major acquisitions[10]. 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.

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 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 di-

visions. 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 the divisions are not obliged to accept the proposals. In the following sections it will be described how Danfoss coordinates the exploitation of the opportunities for synergy described in the first section of this paper.

A: Organizing asset sharing in Danfoss

The three following sections will describe how the sharing of marketing, manufacturing and R&D assets is (and has been) organized in Danfoss. The analysis of the organization of asset sharing is then followed by an analysis of how Danfoss organizes complementarities.

The organization of shared marketing and sales assets

Until 1971 all marketing assets were shared. As part of the early steps towards divisionalization in 1971 the product groups (divisions) were encouraged 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 major reorganizations in 1996 the sales organization was 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 sales subsidiaries they now report directly to the product lines and not to a common sales division. From the existing sales organization 12 regional sales organizations were formed 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 transfer prices with the supplying product lines. Thus, what remains of shared of marketing assets is coordinated through (negotiated) transfer prices. The extent to which marketing assets are shared among the divisions has dropped due to the increasing diversity of the requirements to the marketing capabilities of the sales organization and increasing scale of sales of individual product lines. Thus where product lines have sufficient scale of sale to support their own sales organization, they have assumed responsibility for doing so, whereas the communal sales organization has remained in markets where sales of individual product lines are unable to reach an efficient scale.

The Danfoss trademark is shared under strict guidelines for product quality and how it must be used under corporate supervision. The corporate trademarks and reputation are furthermore protected by policies against using the Danfoss logo on products manufactured by other companies, even if they are sold along with Danfoss products by Danfoss subsidiaries.

Organization of shared manufacturing assets

The growing internationalization of production is reflected both in the parallel process of divisionalization and decentralization that was initiated in the early 1970s, and in the acquisition strategy that gained momentum during the 1980s and 1990s. Production facilities have increasingly become controlled by the divisions, implying among other things a gradual integration of administration and the main production facilities of the individual divisions. However, 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.

By the end of the 1980s only the manufacture of components used in large quantities by multiple divisions remained centralized under corporate responsibility[11]. 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 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.

Major reorganizations beginning in 1996 has, however, put more emphasis on financial responsibility, also of the component manufacturing plants. 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 division who is the

largest internal customer. 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 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.

Manufacturing assets are also shared in the form of transferring equipment between divisions. Asset transfer coordinated through bilaterally negotiated prices. Manufacturing sites and buildings are also shared among the divisions, although each of the foreign manufacturing operations is owned and controlled by one division. Thus, new manufacturing operations are sometimes 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.

Shared component production has thus changed from central planning coordination until 1971 to changing transfer pricing policies 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 corporate 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 after the central manufacturing plants have been exposed to competition from external suppliers.

Organization of shared R&D assets

In the 1960s Danfoss was a quickly growing functionally organized company with a conventional R&D lab, Corporate Technology and Research (CTR).

When Danfoss initiated the process of divisionalization the three newly formed product divisions (product groups) were to encouraged to build separate R&D departments. Since many technologies were considered common to more than one division, CTR was retained in order to serve the common interest of all divisions. However, the extent of asset sharing was reduced since more technologies were now being developed within the divisions which were this way given more control over R&D directly related to their product areas. Since divisional requirements to the development of new technologies has grown more heterogeneous due to the expansion of the product range, asset sharing would have been reduced even if the new divisional R&D had been centrally coordinated.

Sharing of R&D effort among the divisions has continued to decline as the divisions have increased their control of, and responsibility for, R&D. Thus, during the 1970s shared R&D mainly occurred in the form of shared CTR-personnel hired to do work on divisional projects which resulted in a fragmentation of the CTR's activities. The tendency towards fragmentation of the CTR activities was reversed in the 1980s. Under the direction of Jørgen M. Clausen, son of the founder of Danfoss and present CEO of Danfoss, the 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. The increased autonomy did not, however, increase asset sharing, since the technologies under development were not aimed at sharing among divisions.

The product divisions had through the 1980s 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 the 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 turnover[12]. By then around one fourth of total costs in CTR was financed directly by the divisions. While the divisions had increased their own R&D efforts, there were no attempts at promoting inter-divisional sharing of divisional R&D in order to avoid duplication of effort in the divisions. Thus it is fair to say that the sharing of R&D assets among the divisions decreased dramatically during this period.

Over the period, other activities than R&D-projects successively came to play a relatively increasing role within CTR: technical services (consultants pro-

viding technical and procedural assistance to the divisions), management of patents, standardization and certification, quality control, and management of technology across the corporation.

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 established during the reorganization beginning in 1996 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.

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 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. 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.

The decentralization of R&D means that the technological assets have become dispersed throughout the organization and now resides in different business units and geographic locations. This means that sharing of technological assets can no longer be controlled within a single department but has to be organized differently. How Danfoss solved this problem is described in the next section.

Organization of inter-divisional technological asset sharing

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 Tech-

nology Pyramid was assigned to CTR, which as a result added a new role to the department.

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 division[13]. In other words, the Technology Pyramid is not a total directory of the corporate technology base (the complete portfolio of technological capabilities)[14]. 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 Pyramid[15]. 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."*

At the next level in the pyramid were seven "key competencies" defined as those capabilities in which Danfoss wishes to achieve global leadership[16]. 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.

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 management[17]. 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"[18]. 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 devel-

opment 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 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 them. The responsible committee can recommend and approve activities beyond what is budgeted 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.

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). A significant part of technological asset sharing in the form of technical services organized in the Central Service department is, however still coordinated through transfer prices. The move back towards central planning of corporate R&D in the 1980s 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 al-

lows the divisions to mutually adjust their common technological development through the networks of committees, sponsors and gatekeepers. Mutual adjustment was required because R&D had become scattered throughout the organization which means that qualitative information about the nature of technologies and their potential applications has to be collected before the assets can be shared unlike the case of the Central Service department where a number of shared assets have been assembled. The ongoing organizational restructurations has also put increasing emphasis on establishing devices for coordinating sharing of R&D belonging to the divisions rather than sharing assets under corporate ownership. Thus, the dynamics of technology diversification and increasing decentralization has changed the way Danfoss organize and coordinates sharing of technological capabilities.

B: Organizing complementarities in Danfoss

Vertical complementarities

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 initial three divisions were given control of their product specific manufacturing activities, and were furthermore authorized to build their own sales and R&D departments. The trend towards increased divisional autonomy was sustained in the reorganizations in 1988 and 1996 which gave the divisions increased control over their activities. 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 vertical complementarities between R&D and production / marketing has in the last thirty years been strengthened by increasing divisional control over R&D. In the 1970s, when R&D was still centralized to a significant extent in the CTR, the division gained control over the R&D efforts through their direct funding of R&D projects carried out in the CTR. The CTR thus became an extension of the divisional R&D labs providing manpower (human asset sharing) subject to direction from the division supplying the funds to the benefit of vertical complementarities between the project and the divisional activities.

During the 1980s, the division grew to be so large that they were capable of performing most of the R&D activities they needed for running their business. The CTR had also been decoupled from the day-to-day business of the divisions and focused on long term projects and business venture develop-

ment. By the mid-1990s 80% of Danfoss R&D-expenditure was spend by the divisions, whose R&D costs varied from 2-10% of divisional turnover.

As part of the major reorganization in 1996 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. Some of the CTR's R&D projects were transferred to the divisions, and in one case to the "Refrigeration product family", who has thus gained control over the projects which should increase the chance of achieving vertical complementarity.

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 receiving full financial responsibility for its own sales. Only 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 except in markets where sales are too low to reach an efficient scale.

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 planning and direction of the interfaces between the stages of value creation within each of Danfoss' product lines, and relieved corporate management of that responsibility.

Horizontal complementarity

Even though the continued decentralization has decreased centralized coordination of horizontal relationships among the different business in the last thirty years, it has remained an objective for Danfoss to stimulate interdivisional cooperation, which is reported to have been successful, especially in the last six years. The seven committees have played an important role in

stimulating inter-divisional cooperation. Furthermore, 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 or joint functions to facilitate the creation of horizontal complementarities, 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.

The role of the product families and committees is to some extent to assure the inter-divisional coordination which were previously carried out by centralized departments such as the CTR, the sales divisions and the executive committee.

While most of the R&D effort was still carried out in the CTR, the CTR was able to coordinate the development of complementary technologies, but the increasing share of R&D performed by the divisions has reduced the corporate control over R&D. As the product range and the size and number of divisions expanded up through the 1970s, the divisions gained more influence on the types of activities performed in the CTR through an increasing extent of projects directly funded by the divisions (i.e. transfer pricing). By becoming more reliant upon project based funding, the 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, which would otherwise have benefited the realization of horizontal complementarities.

The realization of horizontal complementarities between different technologies common to several divisions may not have been reduced as much, if the CTR had maintained its autonomy. However, the creation of inter-divisional horizontal complementarities between technologies did not increase significantly when the CTR finally did regain some autonomy in the 1980s, since the main projects of the period were not related to integration of technologies or development of complementary products and technologies. Rather, the CTR began to develop new business ventures which were unrelated or uninteresting to the divisions. The implementation of the technology pyramid during the 1990s may, in addition to increasing inter-divisional asset sharing, also have contributed to the realization of horizontal complementarities through the awareness of the different key technologies which the technology pyramid has contributed to disseminate throughout the company. Overall, the realization of horizontal complementarities at the inter-divisional

level have been reduced in the process of ongoing decentralization despite the efforts involved in implementing the technology pyramid.

Horizontal complementarities in marketing have similarly been reduced as the company has continued to decentralize. 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, cf. section 6.2.5) where products from different product lines can be marketed collectively for a specific application. 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.

Thus, horizontal complementarities are now coordinated through specialized organizational structures (i.e. product families, Market Development Division and the technology pyramid) facilitating mutual adjustment, instead of providing incentives for "cross product-line selling". 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.

VI: Concluding remarks

This paper has proposed that of the three basic sources of synergy available to multibusiness firms, asset sharing should be coordinated through transfer prices, vertical complementarities should be coordinated through planning and direction, and horizontal complementarities should be coordinated through mutual adjustment.

The paper has shown that the typology of synergy is useful for describing synergies in Danfoss, thus confirming proposition 1. The trend in Danfoss towards increased emphasis on transfer pricing and mutual adjustment and decreasing direction and planning from the corporate headquarters supports

proposition 2. 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 2) and the proposition that vertical complementarities needs to be coordinated through planning and direction (proposition 3). The relationship between type of synergy and type of coordination mechanism in Danfoss is summarized in table 1.

Table 1: Coordination mechanisms for different synergies in Danfoss

	Coordination mechanism		
Example of synergy:	Transfer prices	Direction and planning	Mutual adjustment
Shared key technologies			Technology pyramid Competence Centers
Shared technical services	Transfer prices		
Shared buildings	Rent		(hearing in planning phase)
Shared components manufacture	Transfer prices		
Shared sales in small markets	Transfer prices		
Shared corporate trademark and reputation	Rules and policies		
Complementary technology development (inter-divisional)			Technology pyramid
Complementary products strategy (Strategic Business Areas)			Market Development division
Vertical complementarity (product-line specific R&D, production and marketing)		Within divisions: product-line control	

Table 1 shows that asset sharing synergies is generally coordinated through transfer prices (rent in the case of shared buildings, zero in case of trademark and reputation), except for shared R&D assets which are coordinated through mutual adjustment within the technology pyramid. Vertical complementarities, as proposed in proposition 3 are coordinated through direction, whereas horizontal complementarities are coordinated through mutual adjustment consistent with proposition 3. Proposition 3 is thus generally supported by the fact that tangible asset sharing is coordinated through transfer pricing, although mutual adjustment have superceded transfer price coordination in the case of R&D asset sharing. However, while the case study of Danfoss has provided some support for the propositions, further empirical

research is needed to test the propositions. Especially case-work on concrete examples of the different types of synergies appear to be needed to test the validity of the propositions.

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[1] Note that transfer prices can also be zero, usually in case of zero marginal costs or high cost of measurement.

[2] Assuming that corporate management resources are more valuable and thus have higher opportunity costs.

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

[4] Van de Ven, Delbecq and Koenig (1976) has added a fourth type of interdependence called team interdependence, which is defined as situations where "the work is acted upon jointly and simultaneously by unit personnel at the same point in time." (Van de Ven et al, 1976: 325). Team interdependencies cannot be divided between units. In thisc paper, activities are defined as team interdependencies, whereas synergy is conceptualized as interdependencies between activities.

[5] 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).

[6] Transactional interdependence is increased the greater the number of different resources 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 another 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.

[7] The contributions are inseparable because one activity cannot create the same amount of value if it is not supported by the other activity.

[8] Unless of course one of the users are capable of damaging the asset, for example by selling low quality products using a corporate reputation for high quality products.

[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.

[10] The corporate function “Mergers & Acquisitions, Legal Affairs and Patents” assists in negotiations and analysis when a division wishes to acquire a company.

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

[12] Divisional R&D expenditure varied from 2% to 10% of divisional turnover

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

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

[15] 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.

[16] 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”.

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

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