

# Incongruities as a source of organizational Renewal in Corporate Management of Innovation and Technology

Jens Frøslev Christensen  
Department of Industrial Economics and Strategy  
Copenhagen Business School, Nansensgade 19, 1366 Copenhagen K  
Phone: 45-38152535, Fax: 45-38152540  
E-mail: jfc.ivs@cbs.dk

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## **Abstract**

The heydays of the central R&D laboratory as the ‘dominant design’ of corporate R&D in large technology-intensive companies is over. The last decades have witnessed not only downsizing of central R&D, but also ongoing experimentation and restructuring of the modes of managing corporate R&D. What is the logic behind these ongoing restructurings? This paper argues that different kinds of organizational incongruities constitute critical sources of change in the organization of R&D. One such organizational incongruity may evolve between the overall changes in the structure and strategy of the company, and the existing mode of managing and organizing R&D. Another type of incongruity relates to internal tensions between emerging new strategic objectives in the R&D organization and the existing mode of managing R&D, or between emerging new R&D structures and the existing R&D-strategy. The paper proposes an analytical framework for understanding what may sometimes seem to be a free-floating or fashion-induced experimental dynamics in the organization of R&D in large industrial corporations. This framework is used to provide a comparative analysis of two Danish technology-intensive companies, one representing a decentralizing organizational trajectory, the other a centralizing and integrative trajectory.

## 1. Introduction

During recent years the traditional ways of organizing industrial R&D in large companies have been subject to massive challenges. The *central lab* placed close to Headquarters and equipped with extended authority to lead and control the company's R&D and innovation policy represented the dominant paradigm for managing R&D in large R&D-intensive corporations after World War II and way into the 1980s (Whittington, 1990). However, as large companies have increasingly become multi-divisional, multi-national, multi-business and multi-technology companies they have become increasingly difficult to assist from central R&D labs (Christensen, 1998b). As a result, R&D-intensive large companies have over the last nearly two decades experienced a general wave of downsizing, decentralization, outsourcing and internationalization of R&D (Coombs and Richards, 1993; Coombs, 1996; Floyd, 1997; Gerybadze and Reger, 1999; Howells, 1990; Iansiti, 1997; Kaufman et al, 1996); National Science Board, 1992; Rubenstein, 1989; Whittington, 1990). However, these tendencies have not been equally powerful in all industries and categories of companies, and rather than a new dominant paradigm of highly decentralized, internationalized and outsourced R&D structures we have witnessed ongoing experimentation and restructuring with different governance structures in which new more market-like and market oriented structures are combined with efforts to assure both long-term and coordinated R&D investments (Birkinshaw and Fey, 1999). Hence, the times of one dominant paradigm of organizing corporate R&D seems over.

What is the logic behind what seems an endlessly ongoing process of restructuring of the R&D organization in many technology-intensive manufacturing companies? This paper tries to combine a structural contingency perspective and an evolutionary perspective in analyzing this theme. It is argued that different kinds of organizational incongruities constitute critical sources of change in the organization of R&D. One such organizational incongruity may evolve between the overall changes in the structure and strategy of the company, and the existing mode of managing and organizing R&D. Most large companies are subject to long periods of relative inertia in terms of organizational and strategic development. They develop along what we shall term *corporate organizational trajectories*. Such trajectories are mostly hard to change, and much restructuring of the R&D organization reflects adaptations to such overall trajectories. Another type of organizational incongruity reflects tensions developing primarily within the R&D organization, either between emerging new strategic objectives in the R&D organization and the existing mode of managing R&D, or between emerging new R&D structures and the existing R&D-strategy.

Since it is difficult, if not impossible, to precisely measure efficiency and effectiveness in management

of innovation and technology, changes in organizational and managerial practices related to R&D tend to be based on management's attempts to come up with organizational solutions to remedy inter-subjectively perceived deficiencies or accommodate new strategic objectives. Such perceived incongruities and deficiencies constitute ongoing sources of organizational modification and restructuring. However, while this contingency perspective seems to provide valid explanations of individual restructuring decisions, the evolutionary notion of corporate trajectories may explain the way the pattern of decisions over the longer term are locked into particular company-specific paths of development.

Hence, the paper proposes an analytical framework in which an evolutionary view of corporate trajectories is combined with a contingency perspective on the strategy and structure of R&D. This framework is used to interpret a comparative, longitudinal study of two Danish technology-intensive companies, one representing a decentralizing organizational trajectory (Danfoss), the other a centralizing and integrative trajectory (Grundfos). The question to be faced is, what are the determinants of the major or minor restructuring associated with the management of R&D, and what is the underlying logic behind the pattern of such decisions over a time span of several decades?

Section 2 gives a short account of the analytical framework. Section 3 and 4 present the two case companies. The historical trajectories of corporate organization and management of innovation and technology are outlined in a descriptive fashion. In section 5 the case studies are analyzed and discussed according to the analytical framework. Section 6 concludes the paper.

## **2 Analytical framework**

The inherent tensions between different and changing strategic objectives and between strategic ambitions and organizational solutions provide a continuous source of trade-off concerns and compromises in the evolutionary development of the company's strategy, organization and culture, and most large and growing companies have to deal with the never-ending issue of harmonizing these concerns in a context of bounded rationality and institutional constraints (Roberts and Greenwood, 1997).

This broad perspective underlies the present analysis of changing modes of managing R&D. Consistent with Chandler's notions of strategy and structure management of R&D is here analytically differentiated into R&D strategy, that is, the explicit or implicit longer term direction of R&D investments, and the R&D structure, that is the organizational mode of managing R&D. Furthermore management of R&D is

divided into two sub-functional categories, management of innovation and management of technology. Management of innovation signifies the management and organization of *the individual innovation processes* with the objective to produce commercially successful product innovations while economizing on time and resources. Management of technology signifies the management and organization of *the company's technology base* (the portfolio of existing and prospective technological capabilities underlying product and process development).

This paper has three objectives. First to align a structural contingency perspective on strategy and structure with an evolutionary perspective on companies' long-term course of development. Second, to apply such a framework to the analysis of the dynamics of R&D management in large companies. Third, to interpret two longitudinal case studies within this framework and, thus, in an explorative way test the validity of the framework.

The contingency perspective used in this paper takes its point of departure in Chandler's (1962, 1977) theory of strategic and organizational dynamics implying that accumulating organizational tensions or incongruities give rise to organizational changes that seek to reestablish coherence between the strategy and the organizational structure of the firm. Extending this perspective into the area of management of R&D, the policy implications would be twofold in that the mode of managing R&D should correspond to both i) the overall strategy-structure constellation and dynamics of the company, and ii) the specific objectives of the company's innovation and technology strategy<sup>1</sup>. However, in the real and highly dynamic world of technology-based competition, perceived organizational incongruities and deficiencies constantly emerge and give rise to pressures for changes in the organization of R&D. In other words, an optimal, one and for all, congruence or coherence will never be obtained.

Two categories of organizational incongruities are specifically pertinent in this particular context: incongruities induced by changes in corporate strategy and structure, and incongruities exclusively associated with the arena of R&D management. The former involves changes in the overall strategy-structure profile of the company that lead to requirements for adaptive changes in the mode of managing R&D, despite possible misalignment with existing priorities in innovation or technology strategy. The latter category of incongruities is associated with tensions internal to the domain of management of R&D. Such incongruities can, in the Chandlerian mode of analysis, be interpreted in terms of the interplay and tensions emerging between R&D strategy and structure: between emerging new strategic

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<sup>1</sup> The notion of strategy is here used in the sense of Mintzberg and Waters (1985) as "a pattern in a stream of decisions" encompassing the full spectrum between deliberate or planned strategy at the one end and emergent

objectives in the R&D organization and the existing mode of managing R&D (in line with the conventional Chandlerian proposition that “structure follows strategy”), or between emerging R&D structures and the existing R&D strategy (in line with the reverse dynamics, namely that “strategy follows structure”<sup>2</sup>). But this category of incongruities may also involve emerging tensions between the two sub-functions of management of R&D, management of innovation and management of technology. One illustration of this would be the way in which a change in the mode of managing *innovation* (for example a change towards decentralized responsibility for product innovation) contribute to undermine both the rationality of the existing mode of managing *technology* (for instance, an up-front technology strategy linked to a central research laboratory) and thereby establish a perceived incongruity between the mode of managing *innovation* and the mode of managing *technology*.

Even if the incongruities are reflected in tensions and organizational and strategic processes within the firm, the drivers of such incongruities may be external or internal to the firm, or both. In the first case, a company’s strategy-structure constellation, which has proved effective in relation to one époque’s industrial, technological or institutional dynamics in its environment, may prove highly ineffective in a subsequent époque characterized by new competitive or other external dynamics, even when the internal strategy-structure mode is highly coherent. Thus, for example the very coherent “strategic planning” style characterizing IBM’s overall corporate strategy and structure as well as the specific mode of managing R&D was highly successful in establishing IBM as the dominant player in the global computer markets in the 1960s, 1970s and early 1980s, but it also contributed to lock IBM into a trajectory (associated with its strong dependence on the mainframe markets) that increasingly was out of tune with the competition (Chandler, 1994)<sup>3</sup>.

It is the proposition of this paper that such a contingency-based framework for understanding organizational change tends to be framed by long-term evolutionary firm-specific trajectories that are hard to change. Evolutionary perspectives on the firm argue that firm behavior is strongly influenced by the routines, capabilities and organizational structures of its previous history (Nelson and Winter, 1982, Teece et al., 1994). In the evolutionary literature the notion of paths or trajectories have primarily related

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strategy, at the other.

<sup>2</sup> Of course, the strategy and structure may also be so intimately co-evolving that it is not possible to identify the one part as driving the other.

<sup>3</sup> As a specific illustration of this interpretation of IBM’s lock-in, Mandel (2000) argues that this position remained even after IBM had launched its first and very successful PC: “IBM ... fell behind in the PC race because it kept trying to protect its profitable mainframe business. As a result, it introduced the laughable PCjr in 1984, with its chiclet-like keyboard, rather than following up the success of the original IBM PC. It’s natural for large corporations to decide that protecting their existing profit streams is more important than taking a chance on an unproven product” (p.27).

to patterns of technology-specific change (“technological trajectories”, cf. Dosi, 1982), to firm-specific or sector-specific patterns of technological changes (the so-called Pavitt-taxonomy, cf. Pavitt, 1984), or to path-dependent dynamics of learning and organizational change (Teece et al., 1994, Lehrer, 2000). Here we shall use the notion of corporate organizational trajectories to signify path-dependent development patterns in the overall strategy-structure constellation. Especially we shall argue that companies with a long history of institutional continuity<sup>4</sup> are subject to long periods of relative inertia in terms of organizational and strategic development.

The two companies studied in this paper reflect different modes of governance: Grundfos represent a more hierarchical mode that is in accordance with the transaction costs arguments against outsourcing of technology and Schumpeterian arguments for in-house protection of radical ideas in their formative stages (Birkinshaw and Fey, 1999). Growth has been induced rather through a strategy of vertical integration than a strategy of business diversification (Christensen, 2000). Danfoss represents an increasingly market-oriented mode that is in accordance with economic efficiency and incentive criteria associated with theories of the M-form company (Chandler, 1962; Williamson, 1975) and some more common trends during the last decades in the development of both the overall corporate organization and the specific R&D organization. Non of the companies have been forced to dramatic turnarounds due to external threats from competitors as the case been to IBM and many other large incumbents (Christensen, 1997, Lovas and Ghoshal, 2000).

The two basic questions of the paper is, i) to what extent and how does the overall corporate trajectory impact on the mode of managing and organizing R&D, and ii) what is the scope for distinct R&D trajectories, as based on the dynamics of co-evolving R&D strategy and structure, either in congruence or at odds with the corporate trajectory? To the extent that the strategic and structural dynamics have been driven fully or partly by external factors it will be indicated, but the external factors will not analyzed separately. In other words, we shall primarily focus on the ‘internal’ process side of the story.

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<sup>4</sup> E.g. companies with a long history without radical reconfiguration of the corporate identity due to mergers, wars, enforced demergers, etc (Cantwell and Fai, 1999). This does not mean that such companies have been immune to strategic, organizational, technological and other kinds of changes. Most companies with a long history, including those with long institutional continuity, have experienced both incremental and radical changes in their strategies and structures.

Figure 1. Similarities and differences between Grundfos and Danfoss

	Differences	Similarities
Danfoss	<ul style="list-style-type: none"> <li>•Related diversification</li> <li>•Outsourcing</li> <li>•Acquisition strategy</li> </ul>	<ul style="list-style-type: none"> <li>•Entrepreneurial history</li> <li>•Family-based ownership</li> <li>•Growth orientation</li> <li>•Institutional continuity</li> <li>•Mass production</li> <li>•Profile of technology base</li> <li>•Industrial market focus</li> </ul>
Grundfos	<ul style="list-style-type: none"> <li>•Narrow business scope</li> <li>•Vertical integration</li> <li>•Internal growth strategy</li> </ul>	

### 3. The trajectories of corporate organization and management of R&D in Danfoss<sup>5</sup>

#### 3.1 Trajectory of corporate organization: A case of decentralization and diversification

Since its establishment in 1933 Danfoss has developed from a one-person firm to a global corporation with an annual turnover of 14 billion DKK (1998) and about 19,000 employees, production facilities in 11 countries, and sales companies in 35 countries. The company today manufactures thousands of different products, particularly mechatronical products for a very diverse set of primarily industrial markets within refrigeration controls, motion controls, and heating and water controls.

Through its nearly 70 years of existence, a characteristic feature of Danfoss has been technology and market-related diversification. The founder of Danfoss, Mads Clausen, a paternalistic entrepreneur, played a decisive role in this development by excessively pushing forward the venturing into related product markets. During most of Danfoss' existence growth and diversification has primarily been generated through internal investments. However, during the last 20 years and especially the 1990s this

<sup>5</sup> This section on Danfoss is based on a comprehensive case study by Iversen and Christensen (1999).

pattern has changed in favor of acquisitions which have primarily been conducted with the objective to strengthen market positions and establish sales synergies by offering related or complementary products to existing customers and through Danfoss' existing distribution and sales network.

Danfoss has also undergone substantial technology diversification. Thus, from an initial mechanical engineering base, Danfoss' technology base has gradually come to include capabilities in mechatronics, hydraulics, electronics, software, and materials. Scale economies, effective and high-quality manufacturing and "design for manufacturability" are critical competitive advantages of Danfoss's most important products - certainly of the most successful of them all: the radiator thermostat.

As Danfoss has grown due to diversification and internationalization, the corporate organization has gone through several stages of change away from the original functional or Unitarian (U-form) structure and towards an increasingly decentralized multidivisional (M-form) structure. The first steps were taken in 1971, a few years after the death of Mads Clausen, when three "product groups" (later to be termed divisions) were established with the assignment to take responsibility for their respective product lines and for building their own development, sales and accounting functions<sup>6</sup>. Much of the manufacturing and purchasing operations, however, remained centralized, just as the central R&D lab retained responsibility for the longer term R&D efforts.

By the mid and late 1980s it became increasingly clear for top management that the corporate organization was stuck halfway between a centralized, functional organization which represented the residual parts of the "old" Danfoss, and a divisionalized and decentralized organization representing the expansion of the divisions and their request for further autonomy. In 1988 subsidizing internal sourcing ended, and the divisions assumed organizational and financial responsibility over parts of the hitherto central purchasing of components and other inputs.

To enhance collaboration between divisions a number of cross-divisional committees were set up covering such areas as standardization, marketing, production technology, product development and information technology. During the 1990s Danfoss has also promoted inter-divisional efforts in nurturing key technologies of importance for more than one division (see below).

The number of divisions has grown to 11 in 1999, and the powerful forces operating in favor of

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<sup>6</sup> The three groups were termed "Compressors Group", "Automation Group" and "Hydraulic and Burner Components Group". The study has involved numerous interviews especially with R&D managers and several visits

divisional autonomy have continued. Decision making responsibilities have extensively been delegated to divisional management, even the right to implement, for example, large venture projects or major acquisitions<sup>7</sup>. In 1997, divisions assumed responsibility over the corporate-level manufacturing plants. The corporate R&D lab was closed in order to strengthen the divisions' responsibility for their own R&D. Furthermore, to promote inter-divisional coordination the divisions were grouped into three divisional groups, Refrigeration Controls, Motion Controls, and Heating and Water Controls according to criteria of similarity and common interest.

Up until the 1970s Headquarters and most of the productive activities were still located near the small town Nordborg where Danfoss was founded. Since then Danfoss has increasingly become a globally distributed company, and in 1997 the number of employees working abroad exceeded the number working in Denmark.

Roughly Danfoss has undergone the classical Chandlerian (Chandler, 1962) organizational trajectory implying a change from the early entrepreneurial organization in which the founder was in full control, to first a functionally differentiated and more professionalized organization, and then - since around 1970 - an increasingly full-fledged M-form structure within which organizational restructurings more or less regularly have taken place.

### *3.2 Towards a decentralized mode of managing innovation and technology*

In the 1960s Danfoss was a quickly growing company with a conventional R&D lab, Corporate Technology and Research (CTR) responsible for both managing innovation and technology development. However, up through the 1970s the newly established and expanding product divisions gradually developed their own capacity for managing innovation. Moreover, they gained growing control over resource allocation decisions and project formulations in CTR. This resulted in increasing numbers of small projects without much coherence and overall guidance. In the 1980s CTR regained significant autonomy by focusing on a more limited number of strategic R&D projects (technology diversification and integration) and venturing projects (radical innovation outside the existing range of Danfoss businesses). However, this simultaneously resulted in a decoupling of the linkages to the divisions.

As the product divisions increasingly became capable of managing their own innovation processes within their respective business domains, CTR gradually changed from being a general R&D lab to

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to Danfoss from 1995 to 1998. Thus, activities taking place in the company since 1998 is not covered by this study.

<sup>7</sup> Moreover, the responsibility for the product lines has increasingly been delegated to the individual product line

becoming a center for corporate management of technology and related services. While most of R&D in Danfoss was carried out in CTR in the 1960s and early 70s, the CTR-based R&D in the early and mid 1990s only covered about 20% of total corporate R&D<sup>8</sup>. By then around one fourth of total costs in CTR was directly financed by the divisions.

Thus, other activities than R&D-projects successively came to play an increasing role within CTR: technical extension services to the divisions, management of patents, standardization and certification, quality systems, and management of technology across the corporation. The latter set of activities were initiated in 1989 when the director of CTR and some divisional R&D managers began to explore 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.

A new tool called the Technology Pyramid was developed with the objective to contribute to the creation and diffusion of technological capabilities. The Technology Pyramid contains a selection of technologies in which Danfoss can (or wants to) claim world-class expertise, and which have significant value for more than one division<sup>9</sup>. In other words, the Technology Pyramid is not a total directory of the corporate technology base (the complete portfolio of technological capabilities). 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 technological competencies across different parts of the corporate organization. A number of cross-divisional committees reviews the status of the key technologies in the corporation, and a technical advisory group is responsible for the practical work and decisions concerning the Technology Pyramid. One to five gatekeepers are responsible for the actual development and monitoring of each of the key technologies, and inter-divisional experience groups implement specific improvement and development activities. A data base is continuously being developed with the aim of storing all relevant information concerning the key technologies for easy access by the users of the Technology Pyramid. 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.

As part of the major decentralization and reorganization measures in 1996 it was decided to close CTR

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units within the divisions.

<sup>8</sup> Divisional R&D expenditure varied from 2% to 10% of divisional turnover

<sup>9</sup> For technologies that are only important to one division, the division in question is expected to take full responsibility.

that 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. However, the management of technology activities were maintained at Headquarters. In 1999 it was decided to collect the various corporate venture and business development projects within a new corporate department that was exclusively to focus on venturing projects<sup>10</sup>. The strategic intent behind this decision was to revitalize the tradition in Danfoss for entrepreneurial business venturing<sup>11</sup>.

The restructuring with respect to R&D - and especially the closure of CTR - have been implemented with the intention to stimulate a stronger bottom-up commitment to and responsibility for R&D. This is reflected in the implementation of a project sponsoring scheme to stimulate a bottom-up commitment to long-term coordinated R&D. According to this scheme the Headquarters can fund 50% of projects if the proposals a) are backed up by at least two divisions, b) have a long-term explorative perspective, and c) do not have a natural home base within one of the divisions. One current example is a program for upgrading the software development competence with participation of seven product lines. A small team from the corporate level coordinates a number of software development projects which, beside developing specific software components, aim at accumulating and sharing capabilities in software development.

Over the last 30 years the corporate R&D activities have gradually been spread throughout the corporation within each of the divisions and the many companies abroad<sup>12</sup>. In a dynamic context in which the product divisions have grown larger, increasingly autonomous, and have build their own R&D functions, there are no doubt that the technology management efforts, especially as linked to the Technology Pyramid and other inter-divisional networking activities, have exerted some overall “guiding” and co-ordination influence on the increasingly dispersed technology base<sup>13</sup>. Not a top-down

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<sup>10</sup> Examples of these ventures are water hydraulics and analytical sensors.

<sup>11</sup> This does not imply that all venturing activity will take place at corporate level. There continues to be venture activities at divisional level as well.

<sup>12</sup> 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 USA), most of the more fundamental R&D activities (non-routine technology diversification and integration, and innovative ventures) still takes place in Denmark. This pattern, however, seems to 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.

<sup>13</sup> It is also likely that the increasing focus on job-rotation of managers as well as other cross-divisional committees and networks have played a similar role in promoting coherence - or at least - to some extent countervailing the inherent tendencies towards fragmentation that are associated with ongoing diversification, internationalization and divisionalization.

guidance, but a guidance based on interaction and consensus building. However, cross-divisional exchange of technological knowledge is generally limited.

#### **4. The trajectories of corporate organization and management of R&D in Grundfos<sup>14</sup>**

##### *4.1 Trajectory of corporate organization: A case of centralization and integration*

Grundfos was established in 1945 and has since then developed from a small artisan company to a global corporation with an annual turnover of 7.5 billion DKK (1998) and over 9,000 employees, production facilities on 5 continents, and sales companies in 34 countries. Today the company is the world's third largest producer of pumps and pump systems and the global leader within circulator pumps. More than 90% of the 8 million pumps produced annually are circulator pumps.

Through most of its nearly 60 years of existence a characteristic feature of Grundfos has been a narrow product market scope (focused on different categories of pumps and pump systems) combined with a consistent policy of vertical integration. Thus, the company has in-house development and production of most of the components embodied in the pumps and the production equipment used in producing the pumps. The production subsidiaries abroad are obliged to buy components from within the group, even if this policy has recently been somewhat relaxed in regard to the more simple manufacturing processes. Generally growth has been driven by vertical integration (for instance of electrical motors, other pump components including electronic control systems, and dedicated tools and machinery), inroads into new pump categories (circulator pumps, centrifugal pumps, submersible pumps), into new application areas (building services, industry, water supply, environmental applications), and into new national markets. Grundfos has predominantly pursued growth through internal investments rather than through acquisitions. The few acquisitions that Grundfos has conducted have been take-overs of former competitors within the pump industry.

Underlying the trajectory in favor of vertical integration has been the consistent commitment to realize scale economies through mass production, and the founder of Grundfos, Poul Due Jensen was, until his death in 1977, a driving force in shaping this strategic focus.

While Grundfos has remained a pump company, the technology base has undergone substantial diversification. From the original mechanical engineering base, Grundfos has acquired distinctive

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<sup>14</sup> This section on Grundfos is based on a comprehensive case study by Christensen et al. (1999). The study has involved numerous interviews especially with R&D managers and several visits to Grundfos from 1994 to 1998.

technical capabilities within processing of stainless steel plates, hydraulics, new materials, and power and control electronics. However, it is a common judgment in Grundfos that the competitive advantage of Grundfos is rather based on the capacity for quickly and effectively combining several distinctive capabilities than on one particularly competitive capability. Especially, Grundfos is renowned for its unique ability to integrate product development, process development, and manufacturing operations, and moreover to integrate the motor, the electronic control system and the pump into an "intelligent" system.

The overall Grundfos organization has remained a functional U-form organization, reflecting the fact that Grundfos has not undergone any substantial business diversification. However, the increasing product segmentation, market differentiation and diversity of the technology base has given rise to a more proliferated organization, in which for example the manufacturing function comprises increasingly specialized sections for specific pump types or components in Denmark as well as abroad, and the sales organization comprise both corporate-level functions, national sales companies, and increasingly strong regional units responsible for the coordination and control of the sales and marketing efforts in the transnational regions. Similarly, the R&D activities have been subject to continuous reorganization and proliferation (see below). Generally, however, the functional and unitary features have remained intact in Grundfos, and still most of the critical functions are situated close to Headquarters in the small town, Bjerringbro where Grundfos was founded.

Like Danfoss, Grundfos has gradually changed from being an expansive entrepreneurial firm to becoming a professionalized functional organization. However, unlike Danfoss, Grundfos never embarked upon the divisionalization wagon, but remained a predominantly U-form organization. However, within this structure, Grundfos has internationalized parts of its manufacturing, sales and distribution activities.

#### *4.2 Centralization and integration of management of innovation and technology*

Within the pump industry Grundfos is perhaps the most high-profile in terms of innovation and R&D. In 1998, 324 million DKK were devoted to R&D, corresponding to over 4% of the turnover. By far the largest share of R&D in Grundfos is devoted to product and process development, and the research that takes place is more applied than basic. For both products and processes, emphasis is focused on improvements through the integration of new technology, including especially electronics, new materials and new manufacturing methods. Product development is targeted at making pumps smaller, increasing

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Thus, this study does not cover any activities taking place in the company after 1998.

their performance, making them more user-friendly, and making them consume less energy. To this may be added the development of pumps for new applications.

Until the mid 1980s the product and process development activities were assembled in one central unit in Bjerringbro. This created a very integrative approach to product and process development, a unique feature of Grundfos. However, in 1985 Grundfos decided to transfer development activities to the individual factory sections dedicated to particular pump categories. This was done to create closer integration between development activities and manufacturing operations, and even if this objective was obtained, some new problems gradually turned up. Since development tasks were carried out by employees who had their normal work linked to operational tasks, the development projects tended to become excessively long and costly. Another problem was the lack of coordination between especially tool and machine construction across the individual factory sections, implying that several identical tools were constructed a year.

The recognition of these problems gradually contributed to create momentum in favor of centralizing R&D close to Headquarters and establishing a project organization. In 1987 top management decided to join the different machine and tool construction sections, as well as the research department with its associated materials laboratory, within a new center to be termed the Technology Center (TC) close to Headquarters' main building. The decision process required considerable discussions especially with the skeptical factory sections.

The primary objective was to build a strong and concerted technological platform that would help maintain and expand the leading position in vital fields such as stainless steel, new materials (e.g., composite materials), surface treatment, and the development of process technologies. The center was inaugurated in 1990 - an investment of approximately 100 million DKK, the largest in the history of the corporation. TC employs around 350 R&D employees and is financed predominantly from the group (more than 523 million DKK a year).

Product development activities, however, still remained distributed among the individual production factories. While TC was being build, the organization of product development was being discussed at a series of strategy meetings. The product development departments were perceived to have become too self-contained and reluctant to engage in close coordination which was considered necessary not only to obtain economies of scope in product design and component sourcing but also to accommodate the increasing requirements for inter-disciplinary coordination of the growing number of complex

technologies used in product development. The discussions resulted in a decision to join all product development departments in one Development Center.

In 1993, product developers and product managers from the different sections were transferred to the newly-built Development Center (DC). A project-oriented form of organization crossing professional and organizational boundaries was set up according to a matrix principle. The interior design of DC, where an open work environment facilitates communication and exchange of knowledge, reflects this project orientation. The close juxtaposition of TC and DC has made direct communication among the altogether nearly 700 employees very easy.

Prior to the decisions to centralize R&D, top management had come to recognize that effect electronics, a field in which Grundfos like most of its competitors had no expertise, would very likely become a critical part of pumps in a not too distant future. Consistent with the general “doing-it-self” philosophy, Grundfos decided in the mid 1980s to become a first-mover with respect to integrating electronics into pumps. The starting point was the ambition to develop a robust and low-price micro-frequency converter. This venture project was situated at a distinct location in Bjerringbro separate from the existing R&D activities. The electronics unit developed a strong entrepreneurial culture quite in contrast to that of the well-established mechanical engineering culture in the existing R&D organization. In cooperation with large foreign semiconductor companies Grundfos moved much deeper into both the development and the production side of ASICs (Application Specific Integrated Circuits) than its competitors, and Grundfos succeeded in becoming the first to develop a micro-frequency converter that makes possible the continuously variable control of speed in the pumps. Today approximately 400 people work in the electronics factory, and for Grundfos the electronics capabilities have come to constitute a corner stone which has contributed to create an in-depth theoretical understanding of motors, pumps and systems.

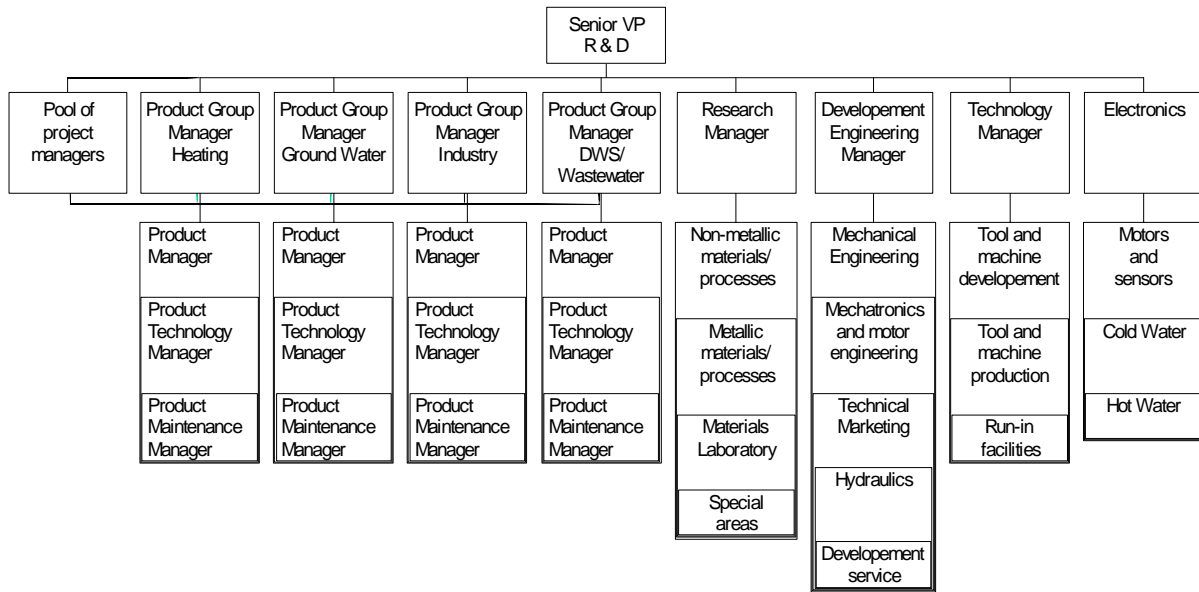
In 1995 a Business Process Reengineering (BPR) analysis on the overall organization of R&D resulted in a decision to create a unitary R&D division with all R&D activities gathered in Bjerringbro. This implied an organizational coordination of TC and DC, and the closure of the relatively marginal product development activities outside Bjerringbro. A graphic representation of the R&D division is shown in figure 2.

The main principle behind the structure of the R&D division has been to align a competence and a business or application perspective. The four boxes and columns to the right in figure 5 represent the

competence-based organization of R&D activities, while the four boxes and columns to the left represent the business and application focus. With respect to the competence perspective, the development engineering function has been grouped into areas of technical expertise. The research function and the function for tool and machine construction (in figure 5 headed Technology Manager) are similarly organized in areas of expertise. When the R&D division was set up in 1996 the electronics expertise in Grundfos was considered to be so new that it was not desirable to separate development and production. However, already the subsequent year the development activities of the electronics factory were organizationally placed under the R&D division, and Grundfos is now trying to integrate electronics development in the R&D organization.

As part of the endeavor to create a more market-oriented R&D organization, the company designated four managers - the Product Group Managers (PGMs), with the

Figure 2: The organization of the R&D division in Grundfos (1996)



Note: "DWS" refers to Domestic Water Supply (private water supply)

Source: Grundfos

superior business responsibility for each of their respective business or application area (Heating, Ground Water, Industry and Domestic Water Supply/Wastewater). The individual PGM has the commercial responsibility for products within his respective business areas and he is supposed to control and nurse these business areas from commercial rather than technological visions. The PGM's tasks are to initiate new product development projects, to follow-up on products in the market and on ongoing projects. To each PGM is associated one or more Product Managers<sup>15</sup>, Product Technology Managers<sup>16</sup> and Product Maintenance Engineers<sup>17</sup>.

For managing the product development projects, Grundfos has set up (from a "pool of project managers") a group of highly experienced Project Managers, who recruit project members from the

<sup>15</sup> A Product Manager acts as a customer ambassador in development projects and is, among other things, responsible for the development of product specifications in the early phases of product development, and for making business plans for new products

<sup>16</sup> A Product Technology Manager is to assure that Grundfos masters the selected technologies. In addition, a PTM is expected to be a support for the rest of the organization (including companies abroad) concerning technology in different applications.

<sup>17</sup> A Product Maintenance Engineer carries out tasks of maintenance and minor improvements of existing products (quality guarantee, production problems, reduction of unit costs). In addition, he provides daily support for operations.

relevant competence areas. The project managers refer directly to the vice president for R&D, but have in addition much contact with the PGM's who initiate new projects.

The development function is now organized as a matrix and project organization. In daily work, separations between departments are broken down and the work is directed at the individual development tasks. All the needed resources are thereby sought mobilized for the individual projects across professional boundaries.

After the experiment with relative decentralization of R&D in the early 1980s<sup>18</sup> Grundfos has gradually centralized corporate R&D within the Technology Center and the Development Center and under the coordination of the R&D division. This development has created a strong commitment to more profound and long-term technological development, to cross-disciplinary integration of diverse technological expertise areas, and to tight alignment between product and process development. In such a centralized R&D organization the market and commercial dimensions in innovation processes tend to become neglected, and Grundfos has for many years tried to countervail this inherent tendency by actively seeking to integrate and strengthen the roles of product managers and product group managers.

## **5. Analytical discussion**

### *5.1 Comparing the corporate trajectories in Danfoss and Grundfos*

The case studies demonstrate that both companies have been subject to consistent trajectories in their overall strategy-structure profiles. It seems as if the two companies already from their early years had been genetically coded for specific trajectories of corporate development, and this can to a large extent be explained by the imprints of their respective founders, Mads Clausen's energetic commitment to diversification through venturing in Danfoss, and Poul Due Jensen's equally energetic commitment to design automatic pumps for global markets through mass production in Grundfos. Both companies were initially subject to similar kind of trajectories involving the transformation of the small paternalistic, entrepreneurial firms into professional large functional firms. No doubt, the vigorous and ubiquitous founders did not always make that process very smooth. However, the trajectory was structurally less complicated in the Grundfos case than in the Danfoss case, because while the U-form was perfectly

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<sup>18</sup> In retrospect this experiment is not by top management considered a failed experiment. Rather, it was considered a necessary learning process that accumulated important insights with respect to issues of coordination between

congruent with the focused business strategy in Grundfos, it was already early on quite at odds with the ongoing venturing and diversification strategy in Danfoss. During the 1950s and until Mads Clausen's death in 1966, the organizational coherence of Danfoss was only assured within the unitarian frame due to a mixture of Mads Clausen's personal controlling endeavors and an increasingly overloaded functional management team.

While Danfoss during the early 1970s embarked on a distinct new corporate trajectory the existing trajectory in Grundfos remained dominant although it had to adapt to new strategic challenges. In Danfoss the new trajectory implied the classical Chandler-story of organizational innovation from a U-form to an M-form structure in congruence with the sustained strategy of diversification (Chandler, 1962, 1977). More specifically, since the practiced pattern of diversification in Danfoss has been (and still is) of the related type (both market- and technology-related), the organizational trajectory towards the M-form (implying decentralization in the form of divisionalization) has at several occasions been counterbalanced by central procedures to pursue coordination (exploit the benefits from relatedness) across divisions, for instance the establishment of cross-divisional committees and a divisional group structure. In the Grundfos case, no distinct organizational discontinuity can be identified. Rather we see that the existing trajectory combining vertical integration, functional differentiation and a quite centralized governance structure has been consolidated while acknowledging the increasing proliferation and internationalization of the product markets served. Especially during the 1970s and 80s the establishment of sales subsidiaries and production facilities in many different countries represented a challenge to the hitherto highly centralized and regionally concentrated sales and manufacturing functions.

The case studies also show that since Danfoss began to implement the M-form structure in the early 1970s, the two companies have pursued very different organizational modes of managing R&D. Below the R&D trajectories in the two companies will be analyzed in order to clarify the role of two kinds of triggers of organizational changes, those related to the overall organizational trajectory and those directly related to incongruities and strategic changes within the R&D organization.

### *5.2 The R&D trajectory of Danfoss*

In Danfoss we have seen that over the last nearly 30 years most technological innovation activities (except for a few venturing projects) have become fully delegated to the product divisions. This development has been imposed by the general forces underlying the divisionalization process, namely

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operations and development.

the incentives for expanding the autonomy and financial accountability of the product divisions. Thus, the change in the development organization was not caused by specific changes in objectives of innovation strategy; rather the causal chain was the reverse, the divisionalization of technological innovation gradually contributed to a change in the de facto innovation strategies. Even if we do not have a full account of the specific styles of managing innovation in each of the 11 divisions, our general impression is that divisionalization of innovation has implied a stronger focus on ongoing product development and less focus on fundamental R&D required for building new distinctive technological capabilities. Moreover, divisionalization has implied increasing focus on inter-functional linkages (e.g. between product development and marketing) as related to the limited business scope of the individual divisions. Altogether this means that by far the most innovative efforts have become dedicated to incremental and custom-specific product development<sup>19</sup>. Prior to Danfoss' embarkment on the divisionalization trajectory, the central R&D lab was responsible for most innovative activities in the corporation. The lab was congruent with the then functional corporate structure, and even if data concerning the objectives of innovation strategy of the lab in the 1960s and early 1970s is sparse, the long-term venture activities seemed to play a prominent role. During the era of divisionalization the central lab increasingly showed incongruity vis-à-vis both the overall tendency towards divisional autonomy and accountability, and the emerging, more incrementally oriented, divisional innovation strategies. This was reflected in increasing difficulties in aligning the long-term horizon of the central lab and the shorter-term commercial inclination of the divisional R&D units. A series of specific measures sought to deal with these problems: Increasing divisional control over the lab's activities, the implementation of a management tool for coordinating technology development in different divisions (the "technology pyramid"), and the increasing divisional funding of the lab projects.

However, the perceived incongruity between the corporate trajectory and the R&D structure did not disappear, and the closure of the central lab in 1996, a decision made by top management and not R&D management, represented a fundamental elimination of this incongruity. As this structural resolution was implemented, the agenda of managerial attention shifted. Even if the justification of the closure of the central lab was to induce divisional R&D to take a more offensive stance in technology strategy, non the less there was some concern that the closure of the lab would rather contribute to reinforce the already existing incrementalist bias in innovative efforts. In a prevailing regime of divisional short-termism, how would Danfoss be able to accumulate radically new technological capabilities and continue the business venture culture that had been the "trademark" of Danfoss throughout its early history? These

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<sup>19</sup> In contrast, some of the venturing projects, especially those organized in the corporate venture function, possess substantial elements of quite radical technical renewal.

considerations led to two initiatives for modifying or countervailing the divisions' natural inclination towards exploitation rather than exploration (Levinthal and March, 1993). One was the co-funding scheme according to which the Group may contribute to fund more radical and cross-divisional innovative investment projects. The other was an attempts to strengthen venture efforts by setting up a venture department close to Headquarters with the responsibility for nurturing a series of high-tech venture projects. Moreover, the technology management procedures associated with the "technology pyramid" were continued at corporate level after the closure of the central lab.

### *5.3 The R&D trajectory of Grundfos*

Grundfos has not experienced a similar break away from the functional structure, hence R&D has not been exposed to strong pressures for decentralization incurred by the overall strategy-structure development as the case has been in Danfoss. Only the increasing proliferation and internationalization of the manufacturing operations have given rise to considerations on how to coordinate product development, process development and manufacturing operations. The relative decentralization of R&D to the individual factories in the mid 1980s both reflected the emergence of new objectives in innovation strategy and some more corporate-wide dynamics. With respect to the former, a commitment to create tighter coordination of innovative and operational activities in order to obtain "design for manufacturability" gained support among R&D management. But also corporate-wide strategic reflections played a role in this decision. The growth dynamics of the late 1970s and early 1980s implied an increasing recognition of the need to internationalize different operational activities, not only the sales and distribution organization but also parts of the production system. In other words, during this phase in Grundfos' history it was increasingly acknowledged that some level of decentralization was necessary in order to realize the growth opportunities in international markets<sup>20</sup>. Finally, the decision to co-locate R&D with the manufacturing sections also reflected the relatively strong political position of the manufacturing side within the corporation. This position can historically be attributed to the founder's strong dedication to quality-based mass production and the tradition of in-house development of the production tools and machinery. Thus, a large share of R&D has always been dedicated to the production side.

For the R&D organization this relative decentralization reflected a quite radical departure from the hitherto centralized structure, and this could potentially have initiated a new organizational trajectory

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<sup>20</sup> The death of the founder, Poul Due Jensen, in 1977 may also have contributed to stimulate new ideas of how to manage and organize the company.

leading to a much more distributed R&D profile in which, for instance, the production units abroad gradually would build up capacity for incremental, custom- and country-specific innovation. However, such a scenario never materialized. Instead, the R&D management increasingly became aware of substantial inefficiencies in the new co-located R&D and manufacturing sections (increasing product development time and poor coordination of R&D among the sections). The emerging dissatisfaction with this R&D structure contributed to create momentum for what eventually, during the late 1980s, developed into a dramatic turnaround in innovation strategy - followed by structure - implying a commitment to become the technological and innovative frontrunner of the pump industry. This “new momentum” underlies the re-centralization processes during the 1990s of all R&D within the Technology Center and Development Center. Even if the centralized nature of technological innovation can be said to match the company’s narrow product focus and functional organization, the more specific organizational set-up for innovative activities reflects well-digested objectives in the company’s innovation strategy rather than specific imprints from the overall corporate dynamics. Grundfos has traditionally been a strongly production- and technology-driven company with a focus on the inter-functional interfaces between product development, process development and manufacturing operations. The substantial investments during the 1990s in fundamental technology development and increasing focus on inter-disciplinary linkages across technologies while maintaining tight relations between product and process development<sup>21</sup> demonstrates a concerted commitment to be a first-mover with respect to implementing quite radical technical renewal of (primarily) existing products and processes. This is furthermore underlined by the long-term investments in building radically new technological capabilities within control electronics.

The recentralization process, however, came stepwise and was not guided by a comprehensive masterplan. First, attention was directed at the process technology development activities which became integrated in the new Technology Center together with a research center in materials technologies. Secondly, focus shifted to the product development function that became collected and integrated into the new Development Center situated right next to the Technology Center. Thirdly, attention was directed, through a Business Process Re-engineering analysis, towards the issue of coordination between the two centers, and as a consequence the R&D division and a matrix-like structure was established in 1996 - an outcome that was not anticipated when the decision to build the Technology Center was taken nearly ten years earlier. Fourthly, the efforts by the late 1990s to organizationally and physically re-integrate the electronics development activities into the R&D organization reflected the maturation of the

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<sup>21</sup> However, the interface between product and process development, on the one hand, and manufacturing operations, on the other hand, is likely to have been weakened as a consequence the re-centralization of the innovation

electronics capabilities and the need to assure a more effective integration of this capability and the “old” mechanical engineering capabilities in ongoing innovation processes. Each of these decisions was taken separately, but they were sequentially related in the sense that they were mobilized as new organizational incongruities or deficiencies were perceived and recognized by management as unintended consequences of the implementation of the previous decision.

An implication of this centralization and integration trajectory characterizing the R&D organization is that Grundfos has chosen for a technological first-mover position and an organizational focus on coordination across technical disciplines and across product and process development activities. The potential down-side of this organizational design is a weak commercial orientation and market coupling associated with product innovation. This problem has been subject to ongoing concern and various attempts to integrate a “market function” in the shape of product managers and more lately product group managers, into the R&D organization. The numerous changes in the tasks, roles and positions of the product managers bear witness to the difficulties of creating a stronger market orientation in the midst of a highly technology-focused organization<sup>22</sup>.

The sequences of these decisions constitute a distinct centralization and integration trajectory since the mid 1980s. Moreover, the massive increase in R&D investments during this period has contributed to regain the technological pioneer role that also characterized the early phases of Grundfos. Combined, the recentralization and the front-runner mobilization can be interpreted as a re-adaptation of the R&D trajectory to match the overall corporate trajectory. In this sense Grundfos is an extremely coherent corporation.

#### *5.4 Comparing the R&D trajectories in the two companies*

As earlier noted management of R&D can be analytically differentiated into two subcategories, management of innovation and management of technology. Management of innovation signifies the management and organization of the individual innovation processes with the objective to produce commercially successful innovations, while management of technology refers to the management and organization of the corporate technology base comprising the portfolio of existing and prospective technological capabilities underlying product and process innovation.

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processes.

<sup>22</sup> To some extent this problem may be less precarious than in many other industries, since most circulator and other pumps that Grundfos sell on the world market are fairly standardized products in which the all-dominant competitive product features are easily internalized in the mental maps of developing engineers (making pumps smaller,

Taking the last 15 years into account, the two companies have witnessed totally opposite trajectories in the organization of R&D. According to the Chandlerian perspective, the mode of managing innovation and technology should reflect the deliberate innovation and technology strategies of the company. However, often the reverse dynamics takes place, namely that the innovation and technology strategies are de facto reflections of an R&D organization primarily imposed by the overall corporate strategy and structure with little explicit considerations for R&D strategies. Below we shall briefly compare the drivers of change with respect to the two subcategories of R&D management.

*Management of innovation* has in Danfoss become the exclusive domain of the product divisions (and increasingly the product lines within the divisions), and the prime driver in this development has been the overall corporate trajectory towards a full-fledged M-form company. The divisionalization of management of innovation has induced increasing incrementalist and market oriented focus in product innovation. In Grundfos the centralization of management of innovation into the Development Center in close association with the Technology Center has been driven rather by the offensive innovation and technology strategy mobilized from the end of the 1980s and onwards, than by pressures to adapt to the overall corporate trajectory<sup>23</sup>. This has induced a commitment in favor of more radical technological innovation.

By delegating management of innovation to divisional level Danfoss has created a “structural” market orientation in innovative activities and, potentially, a weak technology position. In contrast, Grundfos has created a “structural” inclination for a strong technology orientation and a weaker market orientation, the latter of which has been sought modified by the integration of a “market function” (product managers and product group managers) in the central R&D organization.

*Managing technology* deals with the management and organization of the corporate technology base with respect to three types of objectives: technology diversification, technology integration, and management control of technology investments.

*Re. Technology diversification.* Both companies have expanded their portfolio of technological capabilities, and even if the process of technology diversification has followed similar paths (for instance to build expertise in electronics, software and materials technologies), the specific proliferations have differed. Danfoss has a more diverse technology base when specified at a more disaggregate level due

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increasing their performance, and making them consume less energy).

<sup>23</sup> The fact that this re-centralization has also implied a re-adaptation of the R&D organization to the overall

both to Danfoss' larger size and to its more diverse product range. On the other hand, Grundfos probably has developed more in-depth knowledge within some of its high-priority areas. While technology diversification in Danfoss takes place within the 11 divisions without any significant overall guidance, technology diversification in Grundfos is or can be subject to concerted action and long-term corporate commitment in terms of funding and guidance. Even if most R&D is of an applied nature, the substantial long-term investments in materials research and electronics have provided Grundfos with an in-depth know-how in new distinctive technologies that are gradually becoming integrated in the various pump products.

*Re. Technology integration.* Technology integration, involving cross-disciplinary learning, is in Danfoss subject to substantial barriers to the extent this learning involves cross-divisional dialogue and exchange<sup>24</sup>. Especially, the decentralization of corporate R&D has contributed to this development. Even if corporate measures such as the cross-divisional committees (including the Technology Pyramid) and sponsoring projects to some extent promotes such learning, the measures are voluntary by nature and are not assisted by any incentive mechanisms and therefore rarely lead to distinct cross-divisional projects. In Grundfos cross-disciplinary learning is systematically dealt with in the matrix-like organizational set-up of the R&D division in which professional and functional boundaries are sought eliminated.

*Re. Management control of technology investments.* The corporate management control of the divisions in Danfoss primarily focuses on financial performance and this is reflected in the divisional approach to managing innovation and technology, namely a strong concern for relatively short-term commercialization and amortization of R&D investments. This is an effect of the general system of corporate control and not of a specific system for controlling R&D. In other words, economic incentives drive divisions away from explorative, high-risk and long-term orientation in R&D projects towards incremental low-risk projects. In contrast, Grundfos has shown a strong commitment to explorative investments of substantial size in relatively high-risk projects with a long time horizon. These investments are funded by the corporation and not - to the same degree as R&D investments in Danfoss - subject to management control of their commercial pay-off. As a diversified company with strong financial performance incentives, Danfoss has better opportunities for amortizing R&D investments across different product lines and venturing activities than Grundfos where much of the R&D investments has been guided more by managerial judgement of long-term options than by the prospects for short-term commercial pay-off.

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corporate trajectory is here considered a side-effect.

<sup>24</sup> One exception is that one of the divisional groups, Refrigeration Controls comprising three divisions, has set up a

This comparative analysis not only shows that the R&D trajectories of the two companies have systematically been moving in opposite directions over the last more than 15 years. The analysis also shows that the primary drivers of the general mode of managing R&D seems to have differed between the two companies. While in the Danfoss case the mode of managing R&D has been subject to strong corporate forces to adapt to and become congruent with the corporate organizational trajectory, the mode of managing R&D in Grundfos has to a larger extent been driven by deliberate or emergent innovation and technology strategies at the corporate level. The case studies also show that the build-up of organizational tensions and incongruities is a constantly ongoing phenomena and that creating coherence vis-à-vis one set of interfaces may give rise to new evolving incongruities and deficiencies vis-à-vis another set of interfaces (Pavitt, 1998).

## **6. Conclusion**

This paper has proposed an analytical framework for understanding what may sometimes seem to be a freefloating or fashion-induced experimental dynamics in the organization of R&D in large industrial corporations. The framework tries to link a structural contingency and coherence argument with an evolutionary trajectory argument.

The contingency argument suggests that different kinds of organizational incongruities constitute critical sources of change in the organization of R&D in large technology-intensive companies. One such organizational incongruity may evolve between the overall changes in the structure and strategy of the company, and the existing mode of managing and organizing R&D. Another type of incongruity relates to internal tensions between emerging new R&D strategies and the existing mode of managing R&D, or between newly changed R&D structures and the existing R&D-strategy. The two case studies show that such a contingency framework can explain individual sequences of decisions of structural changes in the R&D organization. This perspective, however, has a static bias and is not able to explain the dynamic inter-sequential and inter-temporal changes taking place.

The evolutionary argument can provide this dynamic perspective. The notion of firm-specific organizational trajectories suggest that firms as they mature develop along paths that are based on imprints from strategies and structures implemented quite early on in the history of the firm. Such trajectories are generally highly difficult to change unless they inherently accumulate organizational incongruities that lead to severe deficiencies (as in the typical change from the U-form to the M-form

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common R&D unit to deal with cross-divisional R&D-projects.

structure), or they lead to misalignment with industrial and technological dynamics of the external competition (as in the case of IBM's turnaround from the 1980s and into the 1990s).

The two case studies have shown that the overall strategy-structure trajectories of the corporations are important co-determinants of the long-term development of the R&D organization. While Danfoss has undergone the "classical" change from a U-form to an M-form trajectory, Grundfos has not yet experienced a dramatic change in its corporate trajectory. Neither of the two companies have so far experienced changes in the external competitive or technological environment of a scope justifying or enforcing major turnarounds.

Moreover, the studies have shown that we may identify a firm-specific R&D trajectory reflecting the dynamics of the evolving constellations of R&D strategy (possibly differentiated into innovation and technology strategy) and mode of managing and organizing R&D (possibly differentiated into management of innovation and management of technology). In accordance with a resource-based and evolutionary view companies to a large extent pursue their own routes of development based on their own idiosyncratic learning experiences. This is not to deny the fact that every époque seems to have its own more generic management fashions (e.g. in favor of downsizing, outsourcing, decentralizing, etc.) that are sought diffused through especially the large management consulting firms.

Finally, the studies have shown that even if there seems to be an inherent tendency to pursue corporate coherence (Christensen, 1998, Christensen and Foss, 1997) between the overall organization and the R&D organization, the dynamics of and interplay between the corporate trajectory and the R&D trajectory constantly creates the basis for new incongruities that require managerial response. Thus, the urge for corporate coherence and organizational clarity simultaneously tends to give rise to structurally defined weaknesses that are often later sought remedied by measures which again increase the organizational complexity. The combined contingency and evolutionary perspective seems to provide a promising analytical framework for dealing with such organizational dynamics in companies showing institutional continuity with respect to corporate identity and ownership.

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