Distributed Development

Challenges & Management Practices of Danish Industrial Leaders

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Abstract:

Purpose: This paper discusses management practices of Danish industrial firms in relation to the main challenges they face during the transition from highly concentrated R&D to dispersed R&D.

Design/Methodology/Approach: This is a qualitative study featuring 3 case studies of Danish industrial leaders with globalised operations.

Findings: This research builds on the Offshore Capability Matury Model (OCMM) that describes the process of globally distributing development related activities. The paper identifies drivers and challenges of dispersed development. It also outlines and discusses a variety of practices used by the companies in order to achieve control and coordination of dispersed development. These included hierarchies, routines, cross functional teams, informal links, boundary spanners, and information systems. Moreover, the cases suggest that the role of the firms' R&D function is expanding as they search for the ideal organisational form enabling the dispersed development.

Practical implications: Some firms have turned their global operations into a formidable source of competitive advantage, whereas others hindered their agility. This exploratory study aims to raise awareness about the challenges of distributed development as well as how these challenges can be dealt with.

Key Words: Distributed Development, Dispersed R&D, Global Operations Strategy, Offshore Maturity

Paper type: Forskningsbaseret paper

Introduction

Increasingly complex and knowledge intensive activities are being relocated to areas that once were only concerned with high volume production (Danish Offshoring activity survey, 2008; Couto et al., 2006; Ernst, 2006). R&D began migrating primarily to reduce costs, to tap into local human resources and knowledge, and to be close to production sites and markets (Lewin & Peeters 2006, Eppinger & Chitkara, 2006). Foreign subsidiaries of MNEs are transitioning from being satellites that solely exploited capabilities from the headquarters to capable entities with growing competencies in basic research, applied research, product development and design (Manning et al., 2008, Sun et al., 2007).

Three main reasons have led to the prominence of global collaborative R&D (Boutelier et al., 2006; Dicken, 2003). First, the increased pace of technological change required continuous high investments in R&D and readiness to embrace new technologies at the front end. Second, markets, economies, and environmental and health concerns are now truly global. London & Hart (2004) point to the fact that the saturation of established markets forces MNCs to explore emerging markets. Foreign direct investments have soared in the last decade (UNCTAD, 2005). Third, there is the increased standardization of specifications and protocols.

Although offshoring of industrial activities is likely to present acute challenges for years to come (Doh, 2005), it also carries numerous benefits for home countries knowledge creation and economies (Atkinson, 2007; Piscitello & Santangelo, 2009). Hence, the debate has progressed from whether or not offshoring R&D is beneficial to home countries to which activities to offshore and how to successfully complete the task. As global R&D presents opportunities and threats to international firms, effectively managing the global R&D network has become a precondition to being and staying competitive on a global scale. We attempt to contribute to this debate by addressing how companies can organize this transition to dispersed R&D.

The paper has three parts. First, the conceptual background section presents the constructs and theories employed in the study. It is followed by the methodology and the empirical base of the paper. Next, the discussion outlines the major issues faced by Danish industrial firms when dispersing development related activities. Also, we examine firm practices used to deal with the challenges. Finally, we discuss the key trend towards a greater role of the R&D function. This trend results from the global-

level functional integration challenge and the continual search for an ideal organisational form for distributed development.

Conceptual Background

Centralized vs. Decentralized R&D

Traditionally, centralized R&D is touted as being favourable to radical innovation generation whereas decentralized R&D allows for more incremental innovation (Gassman & Von Zedtwitz, 1999; Tirpak et al., 2006). Centralization is needed if the required knowledge to carry development activities is tacit or difficult to externalize. The degree of tacitness positively correlates with interdependencies between people and components, requiring face to face communication. It makes sense then to keep activities in close proximity to foster radical innovations. In contrast, a high degree of "codifiability" of the required technical knowledge would ensure that information can flow between teams without ambiguity. Decentralized R&D becomes possible with sub-teams focused on different modules and able to control their own resources.

It is important to distinguish between Research and Development in R&D. Research tends to stay close to home based activities, in research institutes and universities, while Development has been internationalized. Whereas basic research is the exploration of the nature of materials and phenomena, applied research is the usage of basic research to develop new technical knowledge. Development consists in transforming that technical knowledge into useful products and service. Gassman (1997) argues that internal drivers of global R&D are external orientation, tapping resources, reducing costs, enhancing competences, and synergies. Specific firm needs cause the move from one configuration to another. Von Zedtwitz (1999) identified archetypes of R&D internationalization on the basis of external drivers. Both internal and external drivers call for more or less centralization of R&D. More often than not, technology driven firms adopt dynamic, hybrid approaches to strike a balance between coordination and control (Gassman & Von Zedtwitz, 2003). As activities are relocated to foreign locations, coordination becomes a key priority and challenge for the firm (Lewin et al., 2006)

R&D Coordination

Coordination mechanisms are the glue of the organisation, allowing for coordination of work related processes and steering individual activities towards organisational

aims (Mintzberg, 1991). Several other authors insist in the primordial role of coordination (Iansiti & Clark, 1994; Bartlett & Ghoshal, 1989). The coordination process enables collaboration, cooperation and sharing of technical knowledge between all parties involved in the development process (Anderson et al, 2007). Anderson and Joglekar (2005) view coordination in new product development as increased integration of activities. The level of uncertainty in managing the new product development process involves a higher degree of process, marketing, creative, and technical uncertainty than typically found in other operations such as production management. This requires an incrementalist approach to deal with disruptions to standards procedures (Zellmer-Bruhn, 2003). The information-processing model in the organisational theory literature (Galbraith, 1973; Sinha & Van de Ven, 2005), suggests that organisational coordination mechanisms are created to manage these disruptions. Those mechanisms range from hierarchies, to contracts or incentive structures, information systems, and modularization of tasks.

Throughout this paper, it is essential to differentiate between product/process integration and vertical integration. Anderson et al., (2007) define product integration as "*the re-weaving together of a product's components that have been distributed across organizational boundaries back into a coherent end product*". Vertical integration refers to ownership of upstream and downstream activities along the supply chain (Perry, 1988)

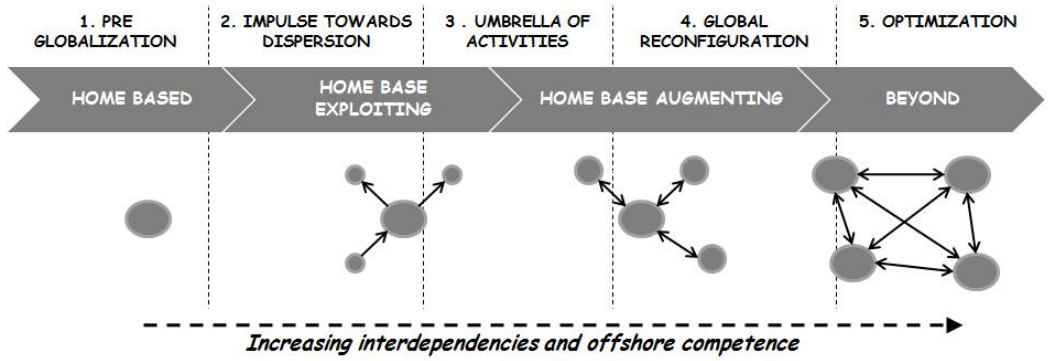
Distributed Development

Previous research has addressed various aspects of product development conducted across organisational and geographical borders (Eppinger & Chitkara, 2006; Von Hippel, 2005; Van de Ven, 2005). The concept of distributed or dispersed process and product development is closely related to a variety of organisational arrangements involving offshoring, outsourcing, offshore outsourcing, and alliances. Offshoring can be defined as the relocation of a business process or entire manufacturing facility to a foreign country (Cavusgil et al., 2008). In this way, offshoring arises through the substitution of overseas activities for domestic activities. Increasingly, low-costs countries are the recipients of offshored activities (Gereffi, 2005; UNCTAD, 2005). The relocation of activities can take place in two ways: (1) captive and (2) outsourcing. Captive offshoring refers to the process of relocating company's activities overseas without giving up ownership and direct control (Kotabe & Murray, 2004). Offshore outsourcing, on the other hand, can be viewed as a

complete or partial discontinuation of in-house domestic activities and, thus, refers to externally supplied activities (Anderson et al., 2007). Although dispersed development may involve multiple organisations, we choose to study the process from the perspective of the single firm.

Offshore Capability Maturity Model

Drawing upon the maturity perspectives of Kuemmerle (1997) and Bessant et al. (2001), Niang & Waehrens (2009) introduced a model tying maturity and offshore competence. The Offshore Capability Maturity Model (OCMM) describes different stages in the relationship between the headquarters and subsidiaries, from pre-globalisation to global reconfiguration of development related activities and beyond. Level 1 is "*Pre globalisation*" with no offshore capabilities. Level 2 is "*Impulse toward dispersed activities*" with ad hoc capability building. Level 3 shows and "*Umbrella of activities*" or defined capabilities. Level 4 starts with the "*Global Reconfiguration*" *where mature dispersed processes are actively managed.* Finally, level 5 shows an ideal state where new configurations are optimized and sustained. As shown in figure 1, foreign subsidiaries appear to exploit competences from the home base when R&D is home based. As their own competences grow, they start to give back to the headquarters, becoming home base augmenting sites. This phenomenon is accompanied by changes in configuration and requires coordination mechanisms.



Source: Niang & Waehrens (2009)

Figure 1: The OCMM: Maturity, Configuration, and Coordination

While the challenges and practices of production offshoring are well covered in the literature, R&D offshoring and distributed development need further exploring.

Therefore, this paper seeks to uncover the challenges faced by Danish firms when offshoring development-related activities. Moreover, it presents strategies and management practices used to mitigate the threats they face. It does so by addressing the following research questions: What are the challenges faced distributing development activities on a global scale? How do they deal with the transition towards globally distributed development?

Research Methodology and Case Studies

The empirical part of the research is based on three exploratory case studies of Danish companies. The case method enables understanding of particular contemporary issues or concepts which have not been deeply investigated (Eisenhardt, 1989; Voss et al. 2002; Yin, 2009). Moreover, case studies are generally preferred for answering 'how' and 'why' questions about a contemporary phenomenon over events in which the investigator has little or no control over (Yin, 2009). Therefore, the case method is well suited for this investigation.

The three cases were selected on the basis of two key criteria: 1) a strong commitment to global reconfiguration of R&D-related activities; 2) sufficient access to potential data (including commitment of interviewees, availability of documents, etc.); Two rounds of interviews were conducted in the period of March 2009-November 2009. The data was collected through semi-structured interviews, documents and archival records. To ensure the accuracy and reliability of the collected data, follow-up telephone conversations were carried out. The first set of interviews focused on developing a holistic view of the companies' global operation networks including their structure, infrastructure, and the interrelations between different functions. Follow-up interviews were directed at the upper management and R&D managers in order to identify R&D-specific problems and some critical firm practices.

Case A - Danish Industrial Equipment Firm

Company A is a Danish equipment manufacturer holding a market leader position. With production in twelve countries and a global sales presence, it is working from a strong international base. Company A has been acquiring two to three companies every year since 2000, signalling a change of mindset from an early ideology of making everything in house to more joint venture and acquisitions. Some of the newly acquired firms still control their own R&D agenda, while others are fully

integrated. The pace of acquisition has quickened recently in par with the restructuring of their main product's market characterized by increased concentration, and firms moving from component to system suppliers, adding more competencies. When referring to Product Development at Company A, an executive talks about a "*Centrally driven, global approach- with a local presence*". Denmark has the strategic vision and remains in firm control, but business unit have their own budget and latitude to select projects, allocate resources.

A fundamental interaction occurs between Production, Product Development (PD) and the Technology Centre (TC). Technology Centres being responsible for technology development and establishment of production lines, a certain degree of coordination is necessary to serve its two customers namely Production and Product Development (PD). Production has already been offshored, and with PD moving out of Denmark, it makes sense that TCs follow customers in their global expansion. Consequently, local TCs have already opened in Hungary and China and a new site is planned in Mexico/USA. Cooperation between foreign units is limited to brief collaboration on assignments and sharing of patents. However, there is a shared agenda at a higher level in relation to operations in different market segments. Though R&D man power in China is growing fast, they have not launched any product range on their own yet, solely supporting central development activities. It is expected however that future responsibilities of developing specific products will be taken over by China. A focus on the U.S.A is needed also as the group is relatively weak in the Americas, where Company A introduced some product ranges over 50 years ago, but can only claim less than 10% share in the market. In time, each "*Triangle*" (TC/Production/PD) will grow increasingly independent and specialized, replicating best practices, but developing own particularities, compatible with local culture and markets. TC Denmark, which designs production equipment for all factories including testers and tools, is to remain the lead factory for the next decades. Employee at foreign TCs are white collars, which means that work is outsourced to local suppliers on a need basis. The electrical parts of testers for instance are manufactured in the Netherlands, the mechanical parts are purchased in Denmark, and the assembly takes places in Denmark. TC Hungary provides more capacity and cost reduction in the tester area supplying spare parts, IT support or any competencies needed around the tester area. Similarly, TC China focuses on tools with 7-8 people building documentation in the tool and automation equipment areas. The operations started with a small base, but are expected to grow rapidly.

The global organisation is nurtured through a positive iterative process by gradually increasing the level of complexity of tasks. For example, both China and Hungary have cast iron mechanical construction units that are routinely assigned tasks by the project manager in Denmark. These parallel activities in Denmark and abroad will continue until it makes sense to move key competencies abroad.

Case B - Danish Firm in the Fashion Industry

Company B is Danish MNE working in the fashion industry. The founder was among the first manufacturers to use robotics and computerized production lines, setting the firm to become a leader in comfort technology. A key particularity of Company B resides in its high level of vertical integration: the firm controls the value chain from raw materials to R&D, production, and retail outlets. Today, Company B has offshored most of its core processes across 11 business units. Development activities are following production abroad partly because of the importance of speed and timing in the industry. The focus is mainly on early concept development or what is supposed to go to market a year from now. A constructive dialogue between Design, Product Development and related channels is needed to ensure delivery of time sensitive fashion items and. Similarly, a dialogue between Production, Engineering and Design enables the teams to meet requirement of different projects. An important task in design is to consider market needs, innovation, and limitations of production, but to challenge the existing standards.

Presently, all new concepts and designs (tooling, design, and new material idea) decision are made in Denmark. The remaining activities upstream and downstream are shared with the foreign sites. High scale production has been offshored to Indonesia, Thailand, China, and Slovakia. The original factory in Denmark is now limited to a small montage unit for prototypes and samples, some tooling, as well as a workshop. The site is in charge of development for kid's apparel which is a low priority. Set up in 1984, the first foreign factory opened in Portugal, but its production has been downscaled as the focus switched to development. Because of relative high production costs compared to the Far East, the Portuguese site has a great sense of urgency "*They are on a burning platform and fighting hard to stay alive"* says a manager. A local team of engineers optimize production techniques as manual labour is more costly: technologies such as laser roughing have been developed by the unit and later distributed to the whole network. Thailand has a development centre and a large production unit. Having a direct source of

information, the local team is able to deal swiftly with a range of technical issues. On the development side, they are responsible for functional gear. China and Indonesia focus solely on production; no development takes place apart from adjusting to specific factory needs. Slovakia has a similar set up, but focuses on automated tasks as labour intensive jobs go to lower cost areas. The previous sites account for the internal production of the group which amounts to about 80% of the global about. The remaining 20% comes from outsourced partners. All internal production is accomplished using a proprietary injection process that guarantees superior quality and comfort. Since 2004, in-house production not based on this method of production has been discontinued and allocated to a Chinese outsourcing division that deals with outsourced partners. Two routes to production mean two 2 streams of R&D and design. One totally internal and the other that goes from the design team in HQ to China, where a technical team redistributes assignments to partners in Indonesia, Thailand, and Vietnam. Development occurs also in the tanneries which constitute another business unit. The main centre is in Holland. Factories in Indonesia, Thailand, and China produce leather for internal production. The high level of integration and control of the value chain are strategic decisions made by headquarters. Again, all decisions are in Denmark, but core competences are moving to foreign montage units.

Case C - Danish Firm in the Mobile Telecommunication Industry

Company C is a leading manufacturer of equipment and systems for global mobile communication. Since its creation in 1981, the company has been providing equipment for maritime, land-based, and aeronautical use, from shipyards, to leisure boats, military and humanitarian organisations. Company C has around 650 employees, of whom half are in the Danish headquarters. The rest of the employees are at a second production site in Denmark and sales offices in Norway, Sweden, USA, Singapore and China. Currently, Danish production is shifting to a second home-based site and an external partner in Thailand. Sourcing from low-cost locations is likely to gain traction due to price pressures in a slow growing market. In the aeronautical sector, some production takes place in the US because of special regulation, but US activities are limited to final assembly and testing.

Over the years, the firm has developed new capabilities through its focus on innovation. The company also gained new competences through mergers and acquisitions. In 2004, a major supplier of equipment for maritime radio-

communication was acquired in Denmark. Along with the new R&D competencies, company C inherited a big production unit which is currently evolving into the consolidated domestic in-house production base. The firm had traditionally viewed itself as an R&D company, with a large share of production outsourced domestic partners. In 2006, a Norwegian competitor in the satellite segment was acquired. Although production in Norway was gradually phased out, some development activities remain. In 2009, a Swedish satellite antenna manufacturer joined the growing network. This new acquisition is expected to strengthen competencies in antenna technology in a bid to increase the product portfolio and gain new markets. Despite the acquisitions, R&D activities remain centralized in Denmark. In future, the trend towards dispersed development is likely to be more significant for two main reasons. First, the high costs of investment required to stay a technological leader may influence company's make-or-buy decisions. The dramatic pace of technological improvement in the satellite segment requires constant investment and update of expertise. Second, the company is starting to see dispersed development as a necessity to stay near production and improve quality, price, supply chain visibility, and production development. Although proximity to markets is not the factor determining production and R&D location decision at the moment, the foreign product portfolio of is increasing and a number of next generation products will be made in Asia, which is also a prime target for new sales. Despite the intensity of collaboration with the new Thai supplier, Company C does not maintain a permanent base in Thailand, rather relying on frequent visits. Internally, the New Product Introduction (NPI) Unit supports the development projects and reorganisation following new acquisitions and foreign expansion. NPI may also be useful to enhance cooperation with external partners.

Discussion

Drivers of offshore maturity and accompanying challenges

Referring to the OCMM, it appears that case A and B are in level 3 with an "*umbrella of activities*", while case C is still in level 2 with an "*impulse towards dispersion*". The number of units keeps growing, and offshore R&D capabilities are increasingly defined, but policies and measures of control are however still heterogeneous. Company A and B have had to consider mainly costs and talent from the onset of the R&D offshoring process. However, the shift from exploitation towards offshore

augmentation of competences creates a renewed focus on asset utilization. A number of innovations (laser rouging for B) have been developed by subsidiaries and subsequently shared. Staying close to production is important for Company A and B. For instance, the 3D design needs to have production next door in order to have an updated knowledge of emerging problems and solutions. This trend is growing, but for now, Danish designers have to travel more often to manage the process.

With internal and external factors driving dispersed development, firms face significant challenges, the first of which is the make-or-buy dilemma. Academics and practitioners alike lack frameworks guiding the R&D outsourcing and offshoring decisions. At Company A, a manager admits: "*we are building the bridge as we go".* Take the case of Company C, where, the renewed commitment to outsourcing is not limited to old or simple products. C does not place products into categories more or less likely to be outsourced because clearly defining some criteria for outsourcing has been an elusive goal. On the one hand, a technologically simple product may require stringent quality requirements that rule out outsourcing. On the other hand, a complex product may have a relatively simple/codifiable production process. Furthermore, distinguishing between core and peripheral activities is proving increasingly difficult. Ketokivi & Ali-Yrkkö (2009) found that unbundling R&D and manufacturing is not always possible. Inter-linkages between tasks and commoditization of previously high value added activities bring the need to question current configurations and practices. Managing dispersed development activities results in the creation or augmentation of coordination mechanisms which take time and additional investments to develop. This example illustrates the difficulty for firms to find when dispersed development is worthwhile and implement it adequately.

During the implementation, organisational issues such as the degree of trust, the level of communication, and coordination dominate. Parker & Anderson (2002) showed the importance of product integration in distributed development. Similarly, the OCMM implies increased integration based on home base generated standards in order to secure a global level of activities. However, the dispersion of development activities complicates product integration (Anderson et al. 2007). With more actors involved, organisational barriers multiply with the physical and psychic/cultural distance of partners. For instance mismatches between the Danish and Chinese culture made it hard for the firms to convey the idea of strict quality requirements. Managers reported the need to fight a lack of trust; a main obstacle to Global Product

Development. The Headquarters often feels that the subsidiaries are not able to take on complex work, which is not always the case.

Supply chain visibility is another problem for firms that have not integrated suppliers in ERP system. They risk losing control over costs, and quality of /products and processes. Other issues involve IPR, transferability of activities and knowledge, and the sustainability of firms' core competences. All these challenges resulting from DPD and affecting DPD would in general undermine firms' efforts to coordinate and control the development process. .

Firm Practices: Coordination and Control

In the simplest sense, control refers to the mode of ownership of suppliers or the influence over partners. Coordination primarily occurs though routines, hierarchies, and incentives. Control and coordination combine to facilitate the management of dispersed development process. In light of existing challenges, how can firms organize dispersed development? Boutelier et al. (2007) explained that rigid structures (functions and hierarchies) enable routines tasks, but constitute barriers to global management. Overlaying structures consisting in informal links and projects that enable cross functional interaction appear to bridge gaps between teams or processes. For instance, Company B holds workshops between Design, Branding and Product development in order to further understand the dispersed development process and agree on problems related to product delivery performance for development of new materials, tools and technical development. As coordination mechanisms are affected by the dispersed development environment, a key priority for the firm becomes how to balance control and coordination. At Company A, integration is proving difficult due to the fact that some foreign sites are fully controlled while others are independent. It becomes necessary to increase coordination though new network level incentives and additional coordination mechanisms such as boundary spanners, information systems, and modular design (Anderson et al, 2007). Incentives and the selection process of suppliers should look to align the objectives of all parties. While modularization aims to self contain tasks, boundary spanners relate to buffers that smooth out the dispersed development process. For instance Company C has a new unit called New Product Introduction Unit (NPI) dealing with a variety of issues that arise during the transfer of activities and competences between sites. Similarly, Company A has technology centres that play a similar role when they coordinate requirements of dispersed production and

product development units, and Company B has a special office in Dongguan China that handles all issues related to outsourcing to foreign partners. Boundary spanners are effective ways to coordinate, but Martin and Eisenhardt (2003) warn about overinvestment in boundary spanning. The role of information systems in DPD range from problem solving (Joglekar & Whitney 1999), synchronization of product lifecycle management tools and exchange of bills of materials across organisational boundaries (Bardhan et al. 2005), and virtual customer interfaces (Nambisan, 2002). As noted by Boutelier et al. (2006), IT systems seem to be underused to coordinate dispersed operations. Company B for instance entered a 5-year services agreement with IBM to support the existing SAP R/3 environment and the implementation of a new ERP business solution that will enable the company to increase flexibility and handle the continuous adjustments necessary in the supply chain. However, there is no Product Lifecycle Management (PLM) system.

In dispersing product development, vertical integration and specialization are two strategic choices that have implications on firms' practices. The level of vertical integration determines the need for more or less coordination. For instance, Company B that has chosen to be highly vertically integrated from raw materials to retail outlets requires higher coordination of value chain activities to best utilize all its assets; modularization is less important. According to Mudambi (2008), cross functional interaction may yield more innovation in this case. In contrast, a specialization model where the firm chooses to outsource peripheral activities like production would require alternate control mechanisms. To illustrate, Company C, which elected not to own suppliers, monitors the turnover on spare parts and organises training and development courses. Caves (2000) argues that direct control of the value chain benefits the firm that can strongly link upstream and downstream activities and has strong competencies in repetitive activities. In contrast a focus on high value added activities or specialization implies decoupling of activities from each other. In such a case, Dhanaraj & Parkhe (2006) emphasize the crucial role of coordination across the firm and orchestration of the network activities to ensure the success of modularization. The specialization strategy is based on the cost driven offshore outsourcing of standardized activities. Doh (2005) insists that such a strategy is likely to create more outsourcing as activities can be transferred to new partners. We may envision a parallel with footloose production (Ferdows, 2008) with its potential pitfalls such as the increased commoditization of products, low employee morale, and fostering future competitors. Anderson et al (2007) insist on the

temptation to shift focus away from a marketing based revenue oriented paradigm to a more basic procuring based cost cutting paradigm. In the case of dispersed development however, cost saving and revenue search are reconciled. Bhardan (2007) argues that "*R&D offshoring brings about a change in emphasis from a static cost minimization focus to a more dynamic value maximization approach"*

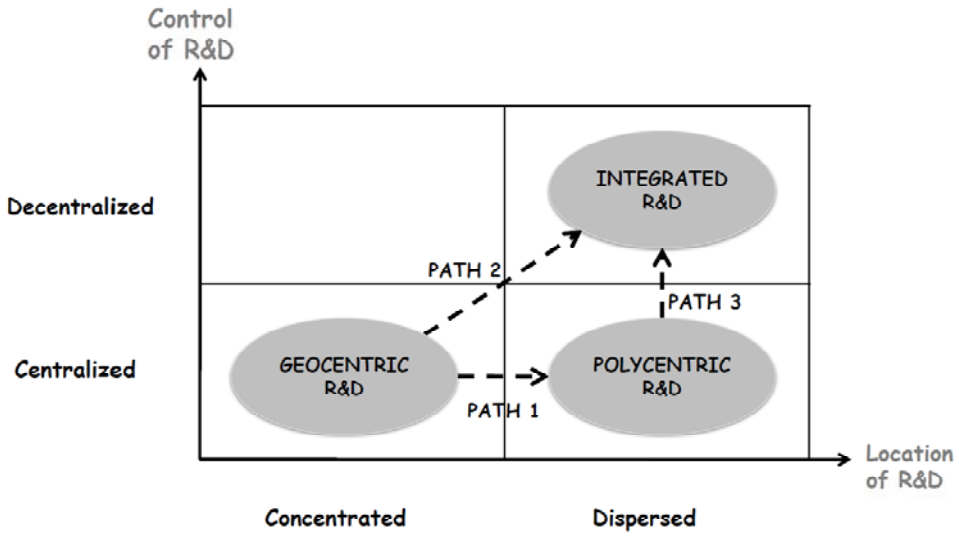


Figure 1: Paths to integration

The case comparison summarized in table 1 does indicate that all three firms have kept their R&D activities centralized in a sense that all major decisions come from headquarters (see table 1). Figure 2 suggests that dispersed development must be combined with decentralization of R&D control to provide synergies. The current scenario is illustrated by "*Path 1",* where control of R&D is centralized despite the global level of operations. The question is whether or not the move to dispersed development requires more decentralization of control to fully benefit from synergies among R&D units (*Path 2)*. Firms that have acquired R&D units or are already polycentric would need to take "*Path 3*". Future research will further explore these paths to integrated R&D.

			A	B	C
Firm Characteristics	**Industry**		**Industrial Equipment**	**Fashion**	**Mobile Telecoms**
	Dominant Function		R&D	R&D, Design	R&D
	Offshore Maturity Level		3	3	2
Location of Activities	**Research**	Home Based	X	X	X
		Offshored	X		X
		Offshore Outsourced			
	Development	Home Based	X	X	X
		Offshored	X	X	X
		Offshore Outsourced		X	
	Production	Home Based	X	X	X
		Offshored	X	X	X
		Offshore Outsourced	X	X	
Drivers	**Internal**	High Cost Of Innovation	X		X
		Low Production Volumes			*X*
		Production Learning	*X*	*X*	
		Supply Chain Control/Visibility	*X*	*X*	*X*
	External	Quality		X	
		Closeness to Market	X		
		Cost Savings	X	X	
		Value Maximizing	X	X	X
		Human Resources	X	X	X
Challenges	**The Market**		X	X	X
	New Context		X	X	X
	New Structures		X	X	X
	New Infrastructures		X	X	X
	Overlaying Structures		X	X	X
	Make- or- Buy Decisions		X	X	X
	Coordination	R&D Communication	X	X	X
		R&D Effectiveness	X	X	X
Practices	**Control**	High Vertical Integration		X	
		Specialization	X		X
		Monitoring Suppliers	X	X	X
		Captive Suppliers		X	
		Relational Suppliers	X		X
		Arm-Length Relationship	X	X	X
	Coordination	Routines	X	X	X
		Hierarchies	X	X	X
		Incentives	X	X	X
		Cross Functional Projects	X	X	X
		Informal Links	X	X	
		Boundary Spanners	X	X	X
		Information Systems	X	X	X
		Modular Design	X		X

Table 1: Distributed Development: Comparative Table of Drivers, Challenges, and Practices

In search of new organisational forms: the Increased Role of the R&D Function

Traditional beliefs to keep core and high value activities in house have driven production abroad, but not R&D. R&D and Production are conceptually separate, but as illustrated in our cases, they are highly interlinked, thus inseparable in practice. Firm A and B started out as production oriented firms but have become R&D and design oriented firm. Firm C has always had a strong focus on R&D, even after acquiring additional production capacity at home and abroad. For all 3 firms, R&D is widely regarded as the core function. However, R&D must increasingly factor in manufacturing, a task that is complicated by foreign operations and the growth in the number of foreign suppliers. This global functional integration puts additional strain on HQ resources. The companies need more awareness of manufacturing processes to guarantee the required level of quality. Therefore, the R&D function experiences expanding responsibilities away from traditional focus. While it was able to disengage earlier and allow the supply chain to take over some tasks, it is now in charge developing products from start to finish. As a senior manager put it, "*R&D is forced to run the show*". Identifying the threshold of optimal outsourcing, allowing adequate product cycle time, reducing time to market, ensuring quality and price are not easy tasks. For these reason, R&D outsourcing has not happened yet for theses Danish industrial leaders.

Conclusions, Limitations, and Further Research

All in all, the case comparison indicates that the firms have varying motives to initiate dispersed development. Nevertheless, they face similar challenges, and aim to increase R&D communication and effectiveness through a range of practices. The key problem related to the globalization of the value chain is the integration of distributed activities. Regardless of the ownership if the value chain, the quest for integration is a key requirement to globally reconfigure dispersed development activities. As suggested in the OCMM, the move to level 4 or the increased maturity of global operations comes with this focus on integration and interdependencies between activities.

This paper fits within the GONE project, an initiative to increase competitiveness of Danish industry through more understanding and better management of global operations. Limitations are to be found in the time scale of the study, which doesn't

allow seeing strategies unfold in practice. Further research will more closely examine interrelations between functions during the development process.

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