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# Emerging capability or continuous challenge? Relocating knowledge work and managing process interfaces

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This study examines interface management as a dynamic organizational capability supporting an increasing global distribution of knowledge work, based on an in-depth case of an automotive supplier. We show how local responses to experiences of task and interface ambiguity following the relocation of R&D processes may lead to a shift of organizational attention from ex-ante process design to continuous process and interface management. Findings suggest that flexible interface manager positions and partnership structures across locations facilitate local experimentation with effective transfer and handling of ambiguous and partially tacit tasks. This enhances the firm's capacity to distribute an increasing variety of knowledge work. Findings stress the importance of interface management in supporting the effective global re-organization of knowledge work, as well as the role of local experimentation, centralized global learning, and flexible structural support for dynamic global capability development.

**JEL classification:** J23, J44, M51, L21, L84, O14, R11, P45, F59, F21.

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## 1. Introduction

Organization scholars have long been interested in the coordination of geographically distributed knowledge work, e.g. research and development (R&D) (Gertler, 2003; Von Zedtwitz *et al.*, 2004; Sapsed *et al.*, 2005). We understand knowledge work as symbolic-analytical work that is typically performed by science and engineering professionals (Drucker, 1959; Reich, 2001). Scholars have argued that the effective redesign, distribution, and reintegration of knowledge work require specific organizational capabilities (e.g. Brusoni *et al.*, 2001, 2009; Hobday *et al.*, 2005). We contribute to this debate by studying the emergence of interface management capabilities. By that we mean coordination capabilities at the points where particular tasks get separated and relocated, and the points where task outcomes get transferred back as inputs for larger workflows (Kumar *et al.*, 2009). We thereby address a critical challenge: to effectively distribute knowledge work across locations, firms need to be able to sufficiently specify tasks and interfaces between them (see e.g. Sinha and Van de Ven, 2005; Blinder, 2006; Mani *et al.*, 2010). However, owing to the partial tacitness of knowledge work, tasks and interfaces are often not fully specifiable, which may result in process and interface ambiguities (Gertler, 2003; Brusoni, 2005). We explore how firms deal with this fundamental challenge, and what role interface management plays in this process.

The empirical context of this study is the growing trend of global sourcing or "offshoring" of knowledge work, including software development, analytics, engineering services, product design, and R&D. The automotive industry has been an important driver of this trend (see e.g. Sobek *et al.*, 1998; Helper and Khambete, 2005), but offshoring of knowledge work can be increasingly observed across manufacturing and even service industries (see e.g. Lewin and Couto, 2007; Couto *et al.*, 2008). Driven by the increasing availability of highly qualified, yet often lower-cost science and engineering professionals in developing countries, in particular US and European firms increasingly source knowledge work from abroad in support of domestic and global operations (Manning *et al.*, 2008; Kenney *et al.*, 2009; Lewin *et al.*, 2009; Demirbag and Glaister, 2010; Jensen and Pedersen, 2011). Scholars have argued that this trend has been promoted by advanced information and communication technology (ICT) and the related ability of firms to digitalize, disintermediate, and remotely perform knowledge-intensive tasks at relatively low costs (Apte and Mason, 1995; Mithas and Whitaker, 2007; Manning, 2012). However, recent studies also indicate that firms face continuous challenges not only related to protection of intellectual property (see e.g. Gassmann and Han, 2004; Bardhan and Jaffee, 2005) but also to designing process interfaces across distances—as reflected by service quality problems and communication flaws between onshore and offshore units (e.g. Levina and Vaast, 2008; Vlaar *et al.*, 2008; Srikanth and Puranam, 2011).

Based on the comprehensive explorative case study of R&D offshoring initiatives by a German automotive supplier, we investigate how interface management capabilities develop to address typical operational challenges of offshoring knowledge work. Our study connects to an ongoing stream of research on the global organization of production and R&D in the automotive industry (see e.g. Clark and Fujimoto, 1991; Kotabe and Swan, 1994; Sobek *et al*., 1998; Sturgeon *et al*., 2008), as well as an emerging stream of micro-level research on offshore implementation practices (see e.g. Levina and Vaast, 2008; Vlaar *et al*., 2008; Srikanth and Puranam, 2011). However, more than prior studies, we focus on how firms try to manage the tension between the perceived need for specifying and standardizing knowledge work packages and interfaces before relocation, and the actual limitations of doing so, given the partially tacit nature of knowledge work. This exemplifies a more general tension: between the need for *ex-ante process design* as a way to standardize processes and reduce contingency and the need for *continuous process management* as a way to handle unforeseen changes, contingencies, and ambiguities on a day-to-day basis (see e.g. Tsoukas and Chia, 2002; Garud *et al*., 2006; Pentland and Feldman, 2008). Similarly, in the case of knowledge work, limitations of relocating tasks "by design" may be moderated by continuous interface management. More concretely, we show that individual responses of managers and engineers to often unforeseen process and interface ambiguities may lead over time to a shift of organizational attention from *reducing the need for coordination* through ex-ante process design to *supporting the need for coordination* through interface management capabilities. This allows firms to source an increasing scale and variety of knowledge work from abroad beyond their capacity to fully specify processes before relocating them.

Our findings contribute, on the one hand, to the ongoing literature on distributing knowledge work (Gertler, 2003; Prencipe *et al*., 2003; Sapsed *et al*., 2005; Hobday *et al*., 2005) and the more recent literature on offshoring knowledge services (e.g. Contractor *et al*., 2010; Grimaldi *et al*., 2010). Unlike previous studies, which have either focused on the need to define and design processes and interfaces before relocating knowledge work (e.g. Sinha and Van de Ven, 2005; Mithas and Whitaker, 2007;), or the challenges in doing so, given the complexity and intangibility of knowledge work (e.g. Brusoni, 2005; Mudambi and Tallman, 2010), we provide a more dynamic perspective that emphasizes not only the importance of continuous learning but also the role of design insufficiencies in promoting a shift of organizational attention (Ocasio, 1997) to the development of continuous and adaptive interface management capabilities, which, in turn, pave the way for an increasing scale and variety of distributed knowledge work.

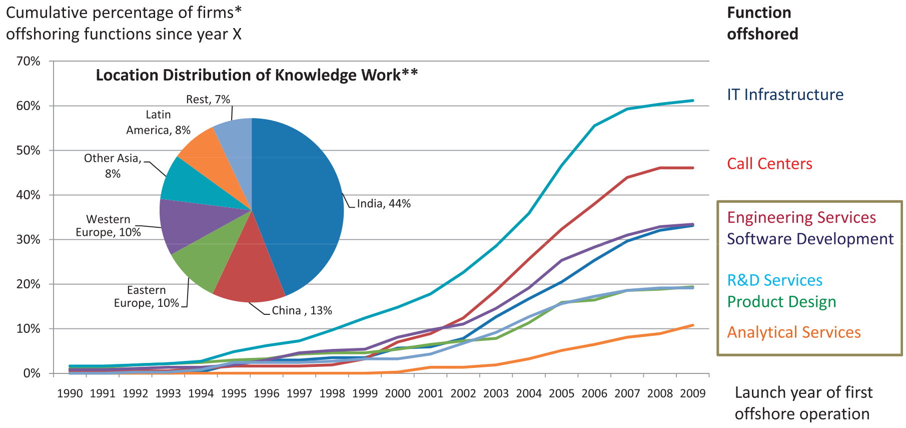
Our findings, on the other hand, contribute to the discourse on organizational practices (e.g. Tsoukas and Chia, 2002) and capabilities (Dosi *et al*., 2000; Winter, 2003). We argue that interface management shows features of dynamic capabilities (Teece *et al*., 1997), as it relies on flexible interface manager roles and cross-unit partner structures to balance the need for designing and allocating tasks and roles, and the need for continuous adaptation to unforeseen contingencies (see also Eisenhardt and Martin, 2000). Thereby, we see a critical role in nurturing the use of individual expertise and skills for effectively adopting and enacting interface management roles in context-adequate ways (see also Gertler, 2003; Levina and Vaast, 2005). Balancing flexible design efforts with expertise- and context-driven emerging practice seems critical for capability development (see also Garud *et al.*, 2006). Our case also indicates the importance of continuous challenges and local experimentation, combined with centralized learning of generalizable principles of effective practice for the development of global dynamic capabilities.

We start out with a review of prior work on organizing knowledge work across locations, focusing on the specification and management of process interfaces. We then analyze how a multinational automotive engineering company has faced and dealt with operational challenges of relocating knowledge work. We then discuss how practices of dealing with these challenges have promoted interface management capabilities. We finally discuss key implications of our findings for research and practice.

## 2. Globalizing knowledge work: the emergence of interface management capabilities

In recent years, the global distribution of knowledge-intensive processes, including engineering, product design, and R&D, has accelerated (Malecki, 2010). Until the 1980s, most firms from developed countries primarily set up engineering and R&D centers in other developed countries, either to enter new markets or to tap into specialized high-tech clusters (see e.g. Florida, 1997; Gerybadze and Reger, 1999; Kuemmerle, 1999; Gassmann and Han, 2004; Santos *et al.*, 2004; Carlsson, 2006). Since the late 1990s, firms have started to increasingly relocate knowledge work to developing regions, such as India, China, and Eastern Europe, to cut labor costs and to benefit from a growing pool of young science and engineering professionals in these regions (Manning *et al.*, 2008, 2012; Lewin *et al.*, 2009). Figure 1 illustrates this trend based on data collected by the Offshoring Research Network (ORN). Since 2004, the ORN has surveyed mainly US (35%) and European (55%) firms across industries, including e.g. manufacturing, software, and financial services, to study historical and recent offshoring projects across business functions (see in more detail Lewin and Couto, 2007; Heijmen *et al.*, 2009). Figure 1 shows that most firms in the ORN database who operate knowledge work remotely (either through captive units or outsourced operations) started relocating such work fairly recently: whereas in 2000, less than 10% of firms performed knowledge work abroad, by 2007 more than 30% of these firms had offshored engineering work or software development, and almost 20% product design or R&D services. Figure 1 also reports typically offshored knowledge work and the overall location distribution of offshore projects.

Many have argued that the increasing trend of globally distributing knowledge work has been promoted by advanced ICT and decreasing global communication



**Examples of Frequently Offshored Knowledge Work**

**Engineering Services:** CAD Design, Engineering Support, Testing, Quality Assurance, Drafting and Modelling
**Software Development:** Application Development, Software Architecture, Database Design
**R&D Services:** Code Development, Research on New Materials, Technology Development
**Product Design:** Prototype Design, Systems Design, Component Design
**Analytical Services:** Data Mining, Market Analysis, Financial Planning, Performance Analysis, Forecasting

**Figure 1** The growing trend of offshoring knowledge work (See for similar charts based on ORN data Lewin and Couto [2007]; Heijmen *et al.*, [2009]; Manning [2013]). *Percentage of US and European firms ($n = 371$) reporting offshoring projects in ORN database (based on launch years). **Percentage of concrete implementations ($n = 1020$) sourced from particular regions (ORN database).

costs (Friedman, 2005; Metters and Verma, 2008), as well as increasing digitalization of tasks and standardization of interfaces (Sinha and Van den Ven, 2005; Mithas and Whitaker, 2007; Leonardi and Bailey, 2008; Manning, 2012). However, prior research suggests that firms continue to face major operational challenges while increasing scale and scope of offshore operations. For example, according to the ORN survey, the two most important challenges as perceived by firms offshoring knowledge work are low service quality and lack of operational efficiency (see Figure 2; see also Lewin and Couto, 2007; Heijmen *et al.*, 2009). Other studies suggest that firms have difficulties in communicating and building up trust and identity with offshore teams (Levina and Vaast, 2008; Vlaar *et al.*, 2008; Mattarelli and Tagliaventi, 2010; Srikanth and Puranam, 2011) leading to unexpected delays, low productivity, and often increasing operational costs (see also Dibbern *et al.*, 2008; Stringfellow *et al.*, 2008; Larsen *et al.*, 2013). Quite interestingly, many firms also prove ineffective in making sufficient use of advanced ICT to facilitate long-distance communication and knowledge sharing (O'Leary and Cummings, 2007; Srikanth and Puranam, 2011). One reason for these challenges is the partially intangible nature of knowledge-intensive work and the related inability of most firms to sufficiently specify workloads before

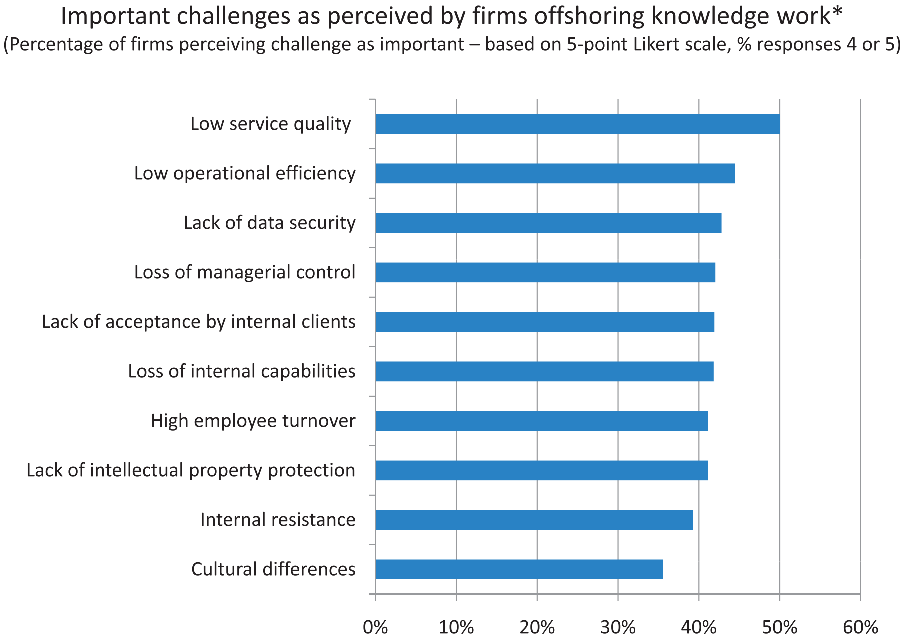


**Figure 2** Challenges related to relocating knowledge work (See for similar charts based on ORN data Lewin and Couto [2007]; Heijmen *et al.*, [2009]). *Data are based on the ORN client survey. Question is asked by particular function—here: engineering services, product design, R&D, software development, and analytical services ($n = 450$ responses).

relocating them (see e.g. Gertler, 2003; Brusoni, 2005; Leonardi and Bailey, 2008; Pentland and Feldman, 2008). In addition, geographic separation reduces the ability to observe processes and engage in face-to-face interaction (Gertler, 1995; Sapsed *et al.*, 2005; Vaast and Levina, 2006; Kumar *et al.*, 2009), which may lead to further operational inefficiencies. Interestingly, only some firms respond to these operational constraints by scaling down remote operations (Sen, 2009). Many firms, by contrast, engage in various learning processes (see e.g. Maskell *et al.*, 2007; Jensen, 2009, 2012), which allow them not only to increase performance but to eventually also increase scale and scope of offshore operations (see e.g. Massini *et al.*, 2010).

We seek to better understand these learning processes with respect to offshoring knowledge work. We thereby focus on a core operational challenge: the specification and management of interfaces between work packages. By interfaces, we mean the points where particular tasks get separated and relocated, and where outcomes get transferred back to feed larger workflows (Kumar *et al.*, 2009). Notably, a number of studies have dealt with interface-related challenges at the *individual* level: many stress the importance of individual managers and engineers in dealing with challenges of communication and trust (see e.g. Vlaar *et al.*, 2008). For example, individuals may facilitate the sharing of tacit knowledge (Gertler, 2003; Leonardi and Bailey, 2008), the development of trust and identity between geographically separated operations (e.g. Levina and Vaast, 2008; Mattarelli and Tagliaventi, 2010), the interpretation of tasks (e.g. Harada, 2003; Vlaar *et al.*, 2008), communication between offshore and headquarter operations (e.g. Sobek *et al.*, 1998; Harada, 2003; Levina and Vaast, 2005), and the establishment of peer contacts across locations (e.g. Gertler, 2003; Jensen *et al.*, 2007).

Other studies specifically focus on the *organizational* level: Although some authors are sceptical about the effectiveness of organizational measures in facilitating interface management—e.g. Levina and Vaast (2005) note that formal boundary spanners (see e.g. Aldrich and Herker, 1977) often do not become "boundary spanners-in-practice"—others do point out a number of firm-level measures to support the effective implementation of distributed work. These include measures of enhancing communication and establishing common understandings of products and specifications (e.g. Srikanth and Puranam, 2011), personnel rotation, and exchange programs to facilitate knowledge transfer and peer-to-peer communication (e.g. Harryson, 1997; Sobek *et al.*, 1998). Other scholars point more fundamentally to the need of organizations to develop certain knowledge and system integration capabilities (see e.g. Hobday *et al.*, 2005; Brusoni *et al.*, 2009) to manage an increasing scale and scope of distributed knowledge work. We would like to connect to this stream of research by focusing on interface management as an emerging global capability. More than prior studies, however, we seek to understand the *process* of capability development, as firms increase scale and scope of offshore operations, thereby integrating the individual and organizational level of analysis.

Our starting point is the notion that interface management can be a potential *organizational capability* rather than just an individual skill. Organizational capabilities denote a firm's capacity to deploy resources in a way that helps the firm survive in a competitive and often changing environment (Penrose, 1959; Helfat and Lieberman, 2002). Organizational capabilities can be to some extent emergent (Kogut and Zander, 1992; Zollo and Winter, 2002), but they typically also follow—or are nurtured by—strategic intentions (Grant, 1991; Dosi *et al.*, 2000). At the same time, capabilities have been linked to the notion of higher-level routines or sets of routines, which allow firms to manage recurrent situations in an efficient and predictable manner (Nelson and Winter, 1982; Grant, 1991; Winter, 2003). However, for firms to also adapt to changing environments, many scholars have pointed to the need for "dynamic" capabilities, which involve the capacity to modify and adapt operating routines (Zollo and Winter, 2002; Winter, 2003), the ability to process new information and resources from the environment (Teece *et al.*, 1997), and/or the ability to apply (and derive) relatively simple and generic rules and structures to (from) new contexts (Eisenhardt and Martin, 2000; Bingham and Eisenhardt, 2011). Not least this dynamic capacity is often linked to knowledgeable individuals who are not only needed to skillfully enact and transform existing routines and structures (Feldman, 2000; Feldman and Pentland, 2003; Wang and Ahmed, 2007) but also whose knowledge needs to be integrated, to some degree, within routines and capabilities themselves for the latter to be effective and adaptable (Grant, 1996a, b).

This interplay between individual skills and organizational routine/structure seems particularly relevant in the context of interface management, i.e. all the activities involved in handling the transfer of tasks, communication between teams, and delivery of results between internal clients and offshore units (Levina and Vaast, 2005; Kumar *et al.*, 2009). However, rather than just describing interface management as a capability, we seek to understand drivers of *capability development*. Similar to previous studies, we emphasize learning processes that are often driven by the encounter of operational problems (Zollo and Winter, 2002; Nickerson and Zenger, 2004). As aforementioned, in the context of distributed knowledge work, distrust, misunderstandings, and low service quality are typical operational challenges firms face. We argued that these challenges result from a core tension: between the need of firms to specify tasks and interfaces between them before relocation, and the limitations of doing so effectively in the context of partially tacit and complex knowledge work. Based on the case study of an automotive engineering firm, we show that this tension—along with cost cutting and other strategic objectives—can become a major driver of developing interface management capabilities. Thereby, firms shift attention from a *process design orientation*—focusing on ex-ante process specification and minimizing interface coordination (see also Baldwin, 2008)—to a *process management orientation*—focusing on effective handling of often situation-specific interface challenges in practice. This orientation involves the global support of local experimentation with coordinating a growing variety of offshored knowledge work. Support may include flexible interface manager roles and promoting cross-unit partnership structures. We argue that this combination of flexible structural support and emergent local practice (see also Garud *et al.*, 2006) can become an important force in developing interface management into a dynamic capability.

## 3. Relocating knowledge work and managing process interfaces: the case of a German automotive supplier

Automotive manufacturers and suppliers are among the pioneers in relocating and coordinating engineering, R&D, and design work across globally distributed locations (Clark and Fujimoto, 1991; Kotabe and Swan, 1994; Sturgeon *et al.*, 2008; Colovic and Mayrhofer, 2011; Manning *et al.*, 2012). Although, in the past, automotive firms mainly distributed engineering, design, and R&D to adapt products to local markets and particular client needs (see e.g. for the case of Toyota, Florida, 1997), more recently, auto manufacturers and suppliers have increasingly used low-cost locations in Asia, Eastern Europe, and Latin America to perform technical tasks in support of domestic and global operations (see e.g. Helper and Khambete, 2005; Manning *et al.*, 2012). For this study, we selected the Germany-based automotive engineering firm MoTec, which has set up both market-driven hubs in the United States and Asia and multiple low-cost R&D hubs, in particular, in Eastern Europe. MoTec is one of the major system suppliers for the premium sector. Driven by the opportunity to lower costs, MoTec has reorganized its R&D operations by offshoring engineering and design work to a number of locations in Eastern Europe, including Romania, Hungary, Slovakia, and Czech Republic.

Next, we study in detail how MoTec has dealt with challenges of distributing design and engineering tasks and managing interfaces between them. Notably, several previous studies in the automotive industry have examined challenges of distributing processes globally (e.g. Sobek *et al.*, 1998; Helper and Khambete, 2005). Sobek *et al.*, (1998), for example, list, based on the example of Toyota, key organizational practices, such as process standards and cross-functional coordination, which have helped facilitate globally dispersed operations. Our case of MoTec, however, goes beyond identifying "best practices". Instead, we take a dynamic perspective on the development of interface management capabilities by focusing on the interplay of global design efforts and local responses to ongoing operational challenges in managing globally distributed work.

### *3.1 Data and methodology*

Case studies have a long tradition in organization research focusing on working practices (see e.g. Barley, 1996; Bechky, 2006; O'Mahoney and Bechky, 2008). More recently, a number of case studies have been conducted in the context of offshoring service work as well (see e.g. Levina and Vaast, 2008; Vlaar *et al.*, 2008; Jensen, 2012). Case studies are particularly valuable for investigating complex social processes, which cannot be easily examined through survey-based designs (see e.g. Yin, 2003) We therefore adopt a case study approach to explore the dynamics of capability development involved in managing globally distributed knowledge work. We aim for "analytical generalization" (Yin, 2003) by identifying processes, categories, and relationships from our data that can inform future research (Eisenhardt, 1989).

MoTec is an interesting empirical case because it allows us to study in detail the the development of interface management capabilities. MoTec has set up multiple R&D hubs within a short period. Through a pilot study at MoTec, we learned about emerging practices of interface management, which was the starting point for us to analyze interfaces and practices of managing them in more detail. As we are interested in interface management as an *organizational* capability, we designed our case study in such a way that we could examine and compare interface management practices across locations. This multi-location case study approach goes beyond past case studies in the context of offshoring, which have typically looked at only one or a limited number of offshore implementations (see e.g. Leonardi and Bailey, 2008; Vlaar *et al.*, 2008).

To investigate the coordination of distributed knowledge work, in particular, product design and engineering support, at MoTec, we used multiple sources of evidence (Yin, 2003) and made multiple field trips for a period of 10 months (2007/2008). We conducted 43 interviews (60–130 minutes each) with managers and engineers at multiple locations: Germany (headquarters), United States, Slovakia, Czech Republic, Malaysia, and Romania. Interviews are listed in Table 1.

**Table 1** List of interviews

| No. | Position/responsibility | Date | Length | Location |
|---|---|---|---|---|
| 1 | Head of R&D Business Unit (BU) A2 | 21/05/07 | 65′ | Phone call |
| 2 | Human Resource (HR) manager | 21/05/07 | 90′ | Germany |
| 3 | Head of production BU A2 | 21/05/07 | 90′ | Germany |
| 4 | Head of R&D BU A1 | 21/05/07 | 90′ | Germany |
| 5 | Head of system engineering BU A1 | 22/05/07 | 90′ | Germany |
| 6 | Head of innovation office BU B | 22/05/07 | 90′ | Germany |
| 7 | Head of electronic brake and safety systems | 22/05/07 | 90′ | Germany |
| 8 | VP strategic projects BU B | 29/05/07 | 60′ | Phone call |
| 9 | Manager product review & quality management (QM) R&D | 05/06/07 | 60′ | Phone call |
| 10 | Head of HR information technology (IT) | 14/06/07 | 60′ | Phone call |
| 11 | Head of HR development | 16/06/07 | 60′ | Phone call |
| 12 | Group board member (HR) | 16/06/07 | 110′ | Phone call |
| 13 | Head of recruiting center | 22/06/07 | 60′ | Phone call |
| 14 | Head of corporate functions systems and services | 19/07/07 | 75′ | Phone call |
| 15 | CEO BU B, group board member | 22/07/07 | 60′ | Germany |
| 16 | Chief Information Officer (CIO) | 25/07/07 | 60′ | Phone call |
| 17 | Head of external cooperations BU A | 17/10/07 | 130′ | Phone call |
| 18 | Head of product line development BU A1 | 07/11/07 | 70′ | Germany |
| 19 | Head of mold design BU A2 | 07/11/07 | 75′ | Germany |
| 20 | Head of mold design BU A1 | 07/11/07 | 70′ | Phone call |
| 21 | Head of global evaluation additional performance | 09/11/07 | 60′ | Phone call |
| 22 | Head of material and simulative evaluation | 09/11/07 | 65′ | Phone call |
| 23 | Head of research institute | 12/11/07 | 80′ | Slovakia |
| 24 | Head of testing affiliate Slovakia | 12/11/07 | 95′ | Slovakia |
| 25 | Head of mold design Slovakia | 12/11/07 | 80′ | Slovakia |
| 26 | Head of benchmarking | 13/11/07 | 60′ | Czech Republic |
| 27 | Head of mold design BU A2 Czech Republic | 13/11/07 | 85′ | Czech Republic |
| 28 | Head of mold design BU A1 Czech Republic | 13/11/07 | 70′ | Czech Republic |

(continued)

**Table 1** Continued

| No. | Position/responsibility | Date | Length | Location |
|---|---|---|---|---|
| 29 | Head of mold design BU A1 | 13/11/07 | 60′ | Czech Republic |
| 30 | Director product development BU A2 USA | 03/12/07 | 90′ | Phone call |
| 31 | Manager materials and simulative evaluation USA | 05/12/07 | 60′ | USA |
| 32 | Director technology USA | 05/12/07 | 75′ | USA |
| 33 | Head of technical product management USA | 05/12/07 | 60′ | USA |
| 34 | Director original equipment product development | 06/12/07 | 90′ | Phone call |
| 35 | Supervisor mold design BU A2 USA | 06/12/07 | 65′ | Phone call |
| 36 | Global evaluation customer interface manager | 11/12/07 | 65′ | Phone call |
| 37 | Supervisor testing Romania | 13/12/07 | 105′ | Phone call |
| 38 | Head of R&D BU A2 | 10/01/08 | 70′ | Phone call |
| 39 | Manager product review and QM R&D | 17/01/08 | 75′ | Phone call |
| 40 | Head of external cooperations BU A | 11/02/08 | 60′ | Germany |
| 41 | Manager product review and QM R&D | 11/02/08 | 60′ | Germany |
| 42 | Director platform development BU A1 | 15/02/08 | 65′ | Phone call |
| 43 | Head of R&D BU A1 | 27/03/08 | 60′ | Germany |
|  | Sum (in hours) |  | 53.5 |  |
|  | Average (in minutes) |  | 75′ |  |
|  | Median (in minutes) |  | 70′ |  |

Interviews focused on challenges of managing product development processes, both locally and in coordination with other locations, in particular the headquarters. We selected interview partners based on their knowledgeability about and involvement in this kind of work at MoTec. We transcribed interviews verbatim and analyzed them by using comparative summary tables, focusing on the coordination of distributed design and engineering work and related challenges. Additional data included presentations, business press releases, organizational charts, and Internet sources. As part of the project, we organized a feedback workshop with major company representatives. The presentation of our case analysis starts with an introduction of the global footprint of MoTec's R&D locations. Then, we examine the process of interface management capability development MoTec has gone through since launching its first R&D offshore projects.

### *3.2 R&D locations at MoTec*

MoTec's R&D and product design had originally been concentrated at headquarters in Germany. In the 1980s, MoTec started expanding R&D operations into Austria and the United States mainly to serve new customers and markets. In the 1990s, MoTec started shifting attention to the growing availability of lower-cost engineers in

Eastern Europe. In the mid 1990s, MoTec opportunistically acquired a competitor in the Czech Republic. To benefit from labor cost advantages, MoTec decided to locate some product tests and mold design tasks at the Czech location. As the demand for molds increased significantly owing to customer requirements, MoTec even built up additional design capacities in the Czech Republic. With a similar mindset, MoTec later on decided to locate an R&D simulation team at a new production site in Timisoara, Romania. These engineers receive their work assignments directly from Germany and accomplish mainly standardized tasks. Both decisions were mainly triggered by cost considerations, and, from the very beginning, MoTec was aware of some of the operational challenges:

> Usually you would try to keep development activities in one place to facilitate communication. [...] It is therefore not reasonable to separate and relocate any activities—the cost factor was the only driver for this. (Head of R&D)

Despite these concerns, MoTec further expanded offshore operations by acquiring a competitor with an R&D unit in Puchov, Slovakia, which is now expected to become a full-fledged R&D pillar. Again, saving labor costs was the main driver for this decision. Although most core R&D and design processes will still be located at headquarters in Germany, the Slovakian affiliate will resume group-wide responsibility for designated tasks. One product manager exemplifies this strategy:

> Puchov will not be just a second-tier development location in the long-term but an equally important hub responsible for entire processes that will not be done in Germany any longer. [...] There will be two complementary development centers. (Product manager)

For example, the Puchov site will be responsible for mold design and simulation processes. In this setup, the Slovakian engineering teams are expected to interact closely with both headquarters in Germany and application engineering, mold design, and testing units in the Czech Republic and the United States.

Apart from their new R&D capacities in Eastern Europe, MoTec also expanded operations in Asia. In particular, MoTec has built up development capacities through another acquisition in Malaysia, including application engineering and testing. According to MoTec managers, Malaysia will have a twin function of market- and sourcing-oriented product development.

To summarize, MoTec's current corporate R&D network is mainly based on two R&D centers in Germany and Slovakia, which are responsible for all fundamental research and seminal developments, and additional smaller R&D units in different countries, which, to some extent, not only do application engineering to adjust to local market needs but also take on global responsibility for certain R&D support services. Table 2 gives a summary of all major development centers, their assigned tasks and mandates, and their interfaces with other locations.

Table 2 List of MoTec R&D location

| Location | Size of location | Mandate/tasks | When and how established (e.g. acquisition) | Ties to other locations (who interact with, processes) | Important changes over time/misc (e.g. changing mandate) |
|---|---|---|---|---|---|
| | Altogether 1000 employees in R&D | 1/3 in testing, 2/3 in R&D | | | |
| Hanover, Germany | Excerpts: 43 employees in technology development, 20 in product line development, 20 in Mold Design, 65 in Material Evaluation, 100 in testing details | Basic development 90% of all R&D in Europe, nearly all machine testing, nearly all platform development | Foundation of company | Bilateral with all other locations | 1996 centralization of R&D tasks in Hanover, 2002/2003 centralization of platform development in Hanover |
| Near Hanover, Germany | Approximately 60 employees | Proving ground | Established 1967 | Tire engineers in Hanover | |
| Traiskirchen, Austria | Closed | R&D | Acquisition; 1985 | | Closed 1996 |
| Aachen, Germany | Closed | R&D | Acquisition; 1979 | | Closed 1996 |
| Charlotte, USA | Approximately 15–20 employees | Technical product management (trend scout, replacement business), specific material evaluation tasks, some mold design, interface management for US market | Acquisition; 1987 | Interface to Hanover (capturing of local market needs, mainly for Product line development replacement in Hanover); mainly managed by traveling | In the past, around 80 people, product development (incl. product line development, advanced product materials) closed (partly moved to Auburn Hills respectively), mold design closed in 2006, replacement business moved to Hanover in 2005, test center closed and moved to Hanover |

(continued)

**Table 2** Continued

| Location | Size of location | Mandate/tasks | When and how established (e.g. acquisition) | Ties to other locations (who interact with, processes) | Important changes over time/misc (e.g. changing mandate) |
|---|---|---|---|---|---|
| | Altogether 1000 employees in R&D | 1/3 in testing, 2/3 in R&D | | | |
| Acron, USA | Closed | R&D | Acquisition; 1987 | | Closed 1996 |
| Mount Vernon, USA | Approximately 25 employees | Application engineering for local market, responsibility for big tires, mold design | Acquisition; 1987 | Basic development in Hanover; only loose ties as tires significantly different in the US; marketing requirements from Charlotte; mold design deals exclusively with Hanover | Hanover has tightened ties in the past years; before completely independent |
| Auburn Hills, USA | Approximately 40 employess (thereof four employees for mold design) | Technology development and adjustments for local customers (application engineering primary business), mold design, testing, interface management | R&D established 2001/2002 to be nearer to US customers | Basic development in Hanover (two dedicated interface managers); testing also for Charlotte and Mount Vernon; interfaces to external customers managed by automotive engineers | Primary business 2002 transferred from Charlotte |

(continued)

**Table 2** Continued

| Location | Size of location | Mandate/tasks | When and how established (e.g. acquisition) | Ties to other locations (who interact with, processes) | Important changes over time/misc (e.g. changing mandate) |
|---|---|---|---|---|---|
| | Altogether 1000 employees in R&D | 1/3 in testing, 2/3 in R&D | | | |
| Uvalde, USA | 15–30 employees (including temporary employees) | Proving ground, testing for US customers and special climatic requirements | Acquisition; 1987 | Close ties with tire engineers in Auburn Hills, some ties to Mount Vernon; if testing for European manufacturers also ties to Hanover | Significant capacity reduction during the past 10 years (originally 160 employees) |
| Timisoara, Romania | 12–15 employees | Finite Element Method (FEM) simulation (standard tasks) | 2001 when production facility established | Main interface with tire engineers from Hanover | Not successful, original capacity plans never realized, tasks to be moved to Puchov in 2009 |
| Puchov, Slovakia | Approximately 200 employees, thereof 100 in testing | Full-fledge R&D (some private brands and regional brands), separate tasks for whole company (e.g. offshore testing), mold design, FEM simulation (in the future) | Acquisition; 2007/2008 | Ties with Hanover and partly Otrokovice (e.g. mold design) and Timisoara (transfer of FEM simulation); interfaces mainly covered by local top management | Joint venture; 1998 |

(continued)

Table 2 Continued

| Location | Size of location | Mandate/tasks | When and how established (e.g. acquisition) | Ties to other locations (who interact with, processes) | Important changes over time/misc (e.g. changing mandate) |
|---|---|---|---|---|---|
| | Altogether 1000 employees in R&D | 1/3 in testing, 2/3 in R&D | | | |
| Otrokovice, Czeck Republic | Approximately 50 employees (thereof 14 Material Evaluation) | Material tests, mold design (industrial tires, replacement business), machine testing | Acquisition; 1993, green field approach for mold design from 1996 on | Material tests: Request from tire engineer in Hanover; preparation of tire part in Hanover; shipment to Otrokovice; mailing of results back to Hanover (also some interaction with Charlotte and Malaysia); mold design: multiple loops with tire engineers in Hanover also interfaces with local mold producer; cooperation with mold design in Puchov | Joint venture 1992; takeover 1993; 1998 abandonment of R&D in Otrokovice and centralization in Hanover |
| Malaysia | Approximnately 30 employees | Machine testing and local development (product line development replacement); Trend Scout; Material evaluation for natural ingredients; all R&D activities for Asia | Joint venture; 2003 | Only interfaces to Hanover | Another unit for China planned (in China for local application engineering) |

## *3.3 Developing interface management capabilities at MoTec*

We now examine the process by which MoTec has developed interface management capabilities across R&D locations. Capability development has been promoted by a continuous learning process, which is driven by strategic objectives, in particular cost saving in the case of MoTec, and by the interplay between two fundamental orientations we call the "process design orientation" and the "process management orientation." *Process design orientation* refers to the notion that processes and interfaces need to be specified ex-ante for tasks to be separated from larger workflows and relocated. At MoTec, similar to other firms, this design orientation—and the related "belief" in smart process design as a way to reduce task and interface complexity and the need for coordination (e.g. Baldwin, 2008)—has been an important driver of relocation decisions (see also Sinha and Van de Ven, 2005; Pentland and Feldman, 2008). Over time, however, this design focus has been complemented at MoTec by a *process management orientation* by which we mean an increasing attention to day-to-day handling of process ambiguities *as* tasks get relocated (see also Pentland and Feldman, 2008). This notion has some similarities with the idea of processes and structures being partly "designed," partly "emergent" (see e.g. Levina and Vaast, 2005; Garud *et al.*, 2006). Yet, rather than seeing design and emergence as two ends of a spectrum, we analyze how global design efforts affect local experimentation, and how, in combination, these two orientations stimulate a learning process that drives global dynamic capability development.

Figure 3 displays the learning process. Next, we describe its elements and the relationships between them based on the case. The first process we analyze is *specifying and relocating new work packages*, along with *the (re-)design of process interfaces* (1). As MoTec relocates operations, they start *realizing various limitations of ex-ante task and interface specification in practice* (2). Although (1) follows a process design orientation, (2) calls it into question and eventually promotes: *Experimenting with various means of process and interface coordination between particular units* (3), which, over time, promotes the *institutionalization and adaptation of practices of process and interface coordination across units* (4). Both (3) and (4) follow an emerging process management orientation. In addition, we discuss an important direct inter-linkage between (1) and (3), e.g. the design of flexible interface manager positions in response to (and support of) local experiments with continuous interface management. Following the suggestion of Pratt (2009), we use "power quotes" in the text to support our findings, and additional "proof quotes" in a table format. Following the analysis, we discuss implications for capability development and related future research.

### 3.3.1 Specifying work packages and (re-) designing interfaces

One key condition for relocating knowledge work at MoTec has been the firm's perceived ability to identify and specify separable work packages and interfaces between them. The main driver for engaging in this search process at MoTec was

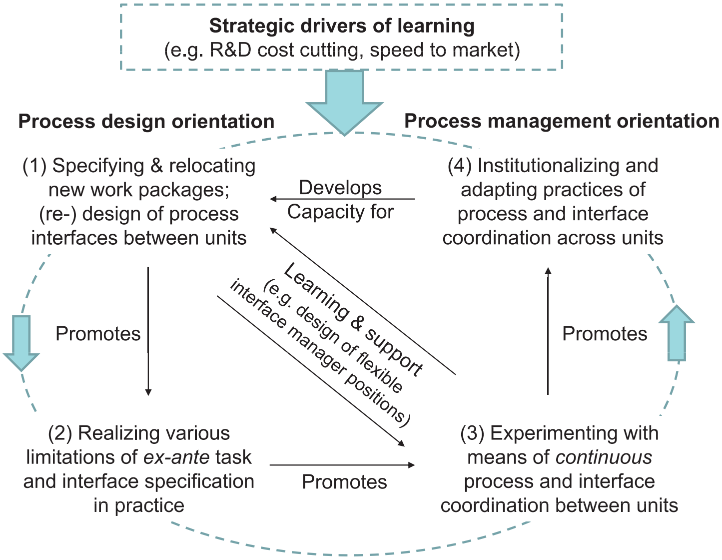


**Figure 3** Development of interface management capabilities.

perceived cost advantages of using offshore engineers. Over time, the cost saving imperative would remain an important driver for search and experimentation (see also Figure 3), as it creates a sense of urgency and pragmatism. One important step in this search process is the identification of potentially separable processes—key here is not "actual" separability, but the *perceived potential* for disintermediation and cost advantages of relocation:

> At times when we are able to name particular development processes or modules, we are able to assess the (cost) advantages and disadvantages of outsourcing as well as offshoring. (Manager Product Review and Quality Management)

Part of this assessment at MoTec concerned the perceived degree of complexity of tasks, the skill sets needed to perform them, and the clarity of interfaces between remote operations and processes at other locations, including headquarters. For example, driven by the opportunity to save R&D costs, one major motivation for selecting mold design as a distinct "offshorable" process was, on the one hand, the perceived high degree of task specification, and, on the other hand, the low complexity of interfaces, in terms of the perceived need for explanation, consultation, and clarification after sending particular tasks. To keep communication and coordination costs low, email was initially expected to fully replace face-to-face or other personal means of communication. The following quote underlines this rationale with respect to mold design:

> In mold design we have seen that it is possible to place an order [...] which is clear and understandable, so we don't get any clarification questions. This order

> can then be processed anywhere, in Otrokovice, Puchov, anywhere. (R&D Manager, Hanover)

This assessment and selection process also involved other aspects, which are illustrated by quotes in Table 3. For example, one important aspect in defining tasks for relocation has been the perceived need for particular technical skills to perform these tasks remotely. Another consideration concerns the potential to generate economies of scale by concentrating highly standardized processes, such as mold design, in particular locations, thereby driving down operational costs.

In sum, the process of identifying work packages for relocation at MoTec has been driven by potential cost advantages, thereby following certain principles, such as task standardization, high degree of specification, and low need for coordination with other locations. Importantly, being able to identify such processes—often before having experience with actually relocating them—has been a key precondition for distributing work globally and for developing capabilities that eventually allowed MoTec to perform remote operations effectively. It is also important to note that this exercise is based on the essential belief, shared within the organization, that processes and interfaces can be sufficiently *designed* to enable relocation. In other words, tasks were identified for offshoring *as if* they can be sufficiently separated and specified. Next, we discuss how this process design orientation has been challenged—yet not questioned at its core—by the actual experience of relocating tasks.

### 3.3.2 Realizing limits of task and interface specification

A major challenge MoTec has faced when implementing initial relocation decisions was that even highly standardized tasks, such as mold design, would often remain unclear, not least because of the partially intangible product or process knowledge needed to understand and perform these tasks. The initial idea to minimize the need for clarification and communication to offshore teams proved to be unrealistic—even in cases where processes are highly standardized. This important realization is illustrated by the following quote from the head of R&D at MoTec.

> We made the experience that even for standard processing of orders accompanying communication is extremely important. Because, no matter how standardized a task is, once in a while you always have those question marks. (Head of R&D, Hanover)

Similarly, MoTec's initial attempt to handle orders entirely by email proved to be insufficient, given the initially unexpected need for communication. This is because email communication limits the often-needed transfer of meaning and context. Even additional digital illustrations, such as pictures, have proven to be insufficient ways to convey meaning. Related to this, MoTec managers made the experience that specific tasks, such as engineering tests, cannot be simply "sent," but rather need to be "discussed" with offshore teams to be understood. This process of discussing and

**Table 3** Realizing the tension: the limitation of task and interface design

| Tensions | Identifying work packages and interfaces | Realizing limits of task and interface specification |
|---|---|---|
| Need to identify tasks and related skills versus actual ambiguity of task specifications | “What we have done is to define whole work packages which can then be transferred to a particular location.” (Director Material and Simulation)<br>“When we disintermediate the services we first check which core skills are actually needed and then we figure out where we can source the service from [. . .]” (Head IT HR)<br>“The rule is to concentrate as much in one location in order to increase efficiency.” (Director External Communication) | “...but this is definitely not sufficient: just to take a few documents and hand them over to someone in China and then to say: Here you are, go ahead and get it done. This does not work, this is too easy.” (Director Platform Development)<br>“Despite all these electronic tools, there is nothing better than getting together around a table and looking at the documents together.” (Head of External R&D Cooperations) |
| Minimizing interfaces versus realizing need for continuous coordination | “These holistic work packages can be easily sliced off. [. . .] On the one hand, they should not be too difficult. On the other hand, they should provide opportunities for growth at the offshore location.” (R&D Manager, Hanover)<br>“You need to analyze each service and then fine-slice it and bring it back together.” (HR IT) | “You get the best results if the product expert meets with the simulation expert regularly throughout the entire process [. . .] Compared to a situation where the product expert says I need this particular result and this is how you get there [. . .] It works, but you don’t get the best result.” (Head of R&D, Hanover)<br>“...there is not only a distance in kilometres, but the communication process is made complicated also by language barriers and cultural differences [. . .]” (Supervisor Simulations, Timisoara) |

generating shared understanding cannot be easily accomplished by email or other means of impersonal communication, as this quote from an R&D manager illustrates:

> As we handle everything by email, there is always the problem [....] that you often don't know exactly what component are we talking about, what is so special about that one.... [...] Even if you have those various means of photography and microscopy available, it remains difficult to directly communicate that by an impersonal channel [email]. (R&D Manager, Hanover)

Finally, internal client expectations often turned out ambiguous, as they allowed for a range of acceptable outcomes, rather than clearly defining acceptable and unacceptable results. What is or is not acceptable remained subject of repeated conversations and negotiations. Because of the ambiguity of client expectations and explicit requests for changes in task requirements by clients, MoTec's offshore teams would often face a situation where initial results had to be modified several times. These modifications proved time-consuming and costly, as offshore teams were unable to communicate with clients directly. In particular, the local absence and resulting lack of direct face-to-face contact to client engineers proved to be a major obstacle in getting tasks done.

> We must do everything by mail, and we lose contact with home-based engineers. It's something completely different for Hanover, and you can go upstairs, see the engineer sitting in his office, and you can discuss results, and you know him, you have personal relations, and everything is a little bit easier. (Engineer, R&D Operations in Otrokovice)

Similar observations have been made by managers and engineers across locations, as illustrated by additional quotes in Table 3. As we discuss next, the collective experience of limitations of process separation, along with the realization of constraints of email-based transfer of even highly standardized tasks, have led to a critical shift of attention from ex-ante process design to continuous interface management.

### 3.3.3 Experimenting with practices of interface coordination

Facing continuous difficulties in specifying tasks for offshore R&D units, a number of MoTec managers and engineers independently started experimenting with different ways of enhancing communication and coordination at the interfaces between offshore and home-based units. Local R&D managers, in particular, would gradually redefine and expand their regular roles and job descriptions. One manager, for example, realized one major operational challenge has been the language barrier between internal clients (e.g. engineers at headquarters) and offshore teams. As a result, he finds himself increasingly in the role of a translator of tasks. This "service" is particularly critical, as MoTec has formal approval procedures in place:

> The form engineer is a German whose English is really bad. I need to moderate here. He would typically write something, and I don't know if this is actually

> understood here in Otrokovice. And this is when I interfere. [...]. Also, we have tedious approval procedures where all designs need to be approved by the engineer in Germany. (Development Director)

Other managers have realized that their role involves making sure that tasks are explained well to offshore engineers—after being delivered by email—and that the process of task execution needs to be monitored continuously. These efforts to enhance communication at different locations promoted the idea at MoTec headquarters to design a new designated position—"interface manager"—to facilitate offshore operations (see Figure 3). Importantly, the introduction of this position was not formalized in terms of particular task requirements. Rather, it served as an "open role," a flexible container of activities to be performed by local managers and/or engineers who receive particular tasks from headquarters, interact with local teams of engineers, and communicate back to internal clients. The purpose of this design initiative was twofold: on the one hand, to recognize and nurture already emerging interface management roles, and to stimulate further local experimentation within often specific and changing task contexts.

In fact, most local managers who were interviewed for this case study had some general understanding of "interface managers" as sets of roles; yet, their actual translation and implementation in practice would substantially vary by context and location (see below). Many local R&D managers would assign interface manager positions in terms of sets of responsibilities fitting present local needs and conditions. One manager, for example, installed a mold engineer as an "interface manager" to improve communication between local mold engineers and developers at the headquarter location. Having both language skills and technical expertise, this mold engineer is expected to serve as a "filter and communicator" between the offshore R&D unit and headquarters:

> We had this idea of establishing an interface manager. This is also a mold engineer – someone who really knows what he is talking about, someone who works right next to the developer. Someone who can communicate one on one with the developer, but also understands the language of mold engineers and who says this is going to be done this way or that way. And he would filter the information sent to the developer. So he is the contact person for the remote designer. A filter and communicator. (Head of Global Evaluation)

Other managers would interpret the need for "interface managers" differently. Rather than installing new positions, they would expand their own roles in line with perceived expectations from interface managers. For example, one manager would elaborate that his various efforts to discuss tasks with local engineers and to serve as coach during implementation is "what interface managers have to do" (see quote in Table 4).

Another key practice that first emerged from local experimentation and was later supported by corporate policies relates to the development of interpersonal contacts

**Table 4** Managing the tension: emerging interface management capablities

| Dimension | Experimenting with coordination between remote units | Institutionalizing / adapting interface management practices across locations / contexts |
|---|---|---|
| Establishing interface management practices | “We compensate the spatial distance to technology development through accompanying processes which involve intensive communication and exchange.” (U.S. Director Product Development)<br>“Personally I think that this [interface management] is only possible through exchange; having people established locally, having the time to get used to these different cultures.” (Director Product Line Development) | “On the one hand, we need to meet the local demands [. . .] But on the other hand we need to make sure that the same R&D service is performed everywhere.” (Manager Product Review)<br>“[. . .] to bring along some patience, the ability to explain things two, three or four times. To see if directions are really being followed. Kind of a checking function, an ankle biter function. This is what interface managers need to do.” (Head of Mold Design) |
| Building lateral ties between units | “You must not let contacts go idle, this is a very important thing. We are planning to have people from Puchov come here to Hanover two months a year, so that those personal contacts can be maintained and strengthened. And yes, this works pretty well for us.” (Director Product Line Development)<br>“Because of established contacts here in Hanover both partners now use telephone more often which helps enhance exchange.” (Supervisor Simulations, Romania) | “We attempt to have designated partners in Hanover to enforce communication between the locations.” (R&D Manager, Hanover, about collaboration with Puchov)<br>“In our departments here in Hanover we made sure to have a colleague from Puchov for at least two years, normally three years. This person can serve as a communication core. This is because, for all our colleagues in Puchov it becomes easier to just contact their own colleague here in Hanover whom they have known for years.” (Head R&D) |

across units to increase interpersonal communication—by telephone—and to compensate for experienced inefficiencies of email. Like interface manager roles, cross-border personal peer contacts first emerged at different locations independently (see also Table 4). A local R&D Manager in Slovakia describes the learning process he has been through, and the contact-making and maintaining practice he has developed:

> I think it's important to maintain personal contacts and this is one of the reasons why I travel a minimum of two times a year to Hanover. My feeling is that directly after my visit in Hanover the communication runs smoothly, one month later it's maybe down to ninety percent, at two months maybe eighty percent, after three months some clients start thinking that our unit is just a bunch of computers. Personal contacts are key, so that our clients understand how we work and what we can do. (R&D Manager, Slovakia)

Over time, MoTec headquarters has established personnel exchanges and regular visits with headquarters as a more general policy to promote communication and coordination across locations. Like in the case of interface manager positions, however, this policy is kept general and vague, and its actual implementation may vary by location. Often, local managers and engineers—like the one quoted above—interpret this policy as a confirmation of their own personal experience and practice. Others have intensified their regular visits of client sites. Next, we describe how interface management has become institutionalized as a generic practice across locations and how this has impacted MoTec's capacity to relocate R&D work.

### 3.3.4 Institutionalizing interface management practices

Continuous local experimentation with interface management practices in conjunction with supporting design efforts by MoTec headquarters has promoted a process of institutionalization of interface management as a set of core practices across locations. These practices may vary by task and team context, but core principles of bundling interface manager roles through engineers or local managers, and of establishing cross-unit ties through regular contacts and exchanges have become very similar. As noted by a manager, MoTec has thereby tried to reconcile the need to account for specific local conditions and task requirements, and the need to raise overall quality standards of distributed R&D processes across locations (see quote in Table 4).

One important facilitating factor in this process has been the centralization of core R&D in Hanover. Although particular R&D processes, such as engineering tests and mold design, are performed in various offshore locations, most internal client requests are sent from MoTec's R&D headquarters. This structural setup has allowed MoTec, on the one hand, to learn from various local experiences with handling work packages offshore, and, on the other hand, to derive general principles of facilitating offshore operations. In other words, processes of parallel experimentation at separate locations have been combined with processes of centralized learning (at headquarters). To facilitate this learning process along with the promotion and diffusion of interface management practices across locations, MoTec has established partner structures where interface managers in Hanover typically manage workflows with various peers in different locations:

> We attempt to have designated partners in Hanover to enforce communication between the locations. (R&D Manager, Hanover)

Another important integration mechanism has been centralized training measures in Hanover. Although in the past, training of offshore engineers has primarily served the purpose of building up skills and ensuring quality standards, MoTec R&D managers have increasingly realized the potential of trainings to establish peer networks across locations to facilitate communication. Trainings may vary in intensity, duration, attendance, and frequency (see e.g. quotes in Table 4); yet, the basic principle of cultivating networks remains the same. The following quote nicely illustrates the multiple—both skill and network developing—roles of trainings at MoTec headquarters:

> The guys from Malaysia went to Hanover for up to two years to get introduced in our processes, to be trained sufficiently and to get embedded into the whole network they need to work effectively. (R&D Manager, Hanover)

In sum, MoTec has established various structures and measures to help institutionalize principle of interface management across locations and contexts of application at MoTec. These measures have been rather generic to allow for continuous adaptation and experimentation of interface management practices in response to incoming tasks. As a result, MoTec has established a rather dynamic interface management capability, which has increased its capacity to redistribute knowledge work—even if its ability to fully *specify* tasks and interfaces—by design—remains limited.

## 4. Discussion: the emergence of interface management capabilities

In this study, we investigated, based on the comprehensive case of an automotive engineering firm, how firms develop interface management capabilities in the context of globally distributed knowledge work. By interface management capability, we mean the organizational ability to manage the relocation of particular tasks, and the return transfer of task outcomes for integration into larger workflows (Kumar *et al.*, 2009). We thereby focused on a critical tension: between the perceived need of firms to define and specify processes and interfaces before relocation (e.g. Blinder, 2006; Mani *et al.*, 2010), and the often-limited ability to fully specify processes and interfaces, given the partial tacitness of knowledge work (Gertler, 2003; Brusoni, 2005; Leonardi and Bailey, 2008).

We show that interface management capabilities help deal with this challenge. They are based on a critical shift of organizational attention from ex-ante process design to continuous process management. Based on a strong initial *process design orientation*, many firms, like MoTec, attempt to drive down R&D costs (and/or increase speed to market) by trying to identify and specify tasks within larger workflows, which can—at least potentially—be separated and relocated without much need for long-distance coordination (see also Sinha and Van de Ven, 2005; Mithas and Whitaker, 2007). However, as knowledge work gets relocated, firms—again like MoTec—often experience rather unexpected process and interface ambiguities owing to the partially tacit nature of knowledge work (see e.g. Gertler, 2003). We argue that this realization can be an important trigger for a shift of attention from "optimal" process design to effective process management on a day-to-day basis. This *process management orientation* may involve the promotion of continuous local experiments of engineers and managers with enhancing communication and facilitating the transfer and translation of tasks and objectives (see also e.g. Leonardi and Bailey, 2008). Assisted by a centralized corporate R&D network, local experiments can stimulate organizational learning and global support, e.g. the promotion of interface manager positions and partner structures and practices, e.g. regular visits of offshore engineers at headquarters for network-building. The MoTec case shows that these measures can serve as flexible "principles" to guide local experimentation and adaptation of interface management practices. Over time, continuous local learning in exchange with headquarters-based managers can help institutionalize these principles across the corporate network and create an enhanced capacity for distributing knowledge work.

## 5. Implications for future research

Our findings have important implications for research on globally distributed knowledge work. Similar to prior studies, our case emphasizes operational challenges resulting from the partial tacitness of knowledge work (Brusoni, 2005) and related insufficiencies of email-based long-distance communication (McDonough, 1999). Our study confirms the importance of individual managers and engineers in supporting the transfer of tacit knowledge between geographically separated units (Gertler, 2003; Harada, 2003; Sapsed *et al.*, 2005). Yet, our study goes beyond identifying individual coping strategies or particular measures at the firm level in support of managing globally distributed work (see e.g. Harryson, 1997; Sobek *et al.*, 1998; Jensen *et al.*, 2007). Rather, we have sought to identify more general dynamics of capability development at the organizational level—focusing on the critical aspect of interface management. We thereby addressed the important question to what extent interface management practices are (or can be) "designed" or whether they "emerge" over time, thereby integrating the individual and organizational level of analysis (see also Brusoni *et al.*, 2009).

Our findings show that interface management capabilities, including the use of interface managers as effective "boundary spanners-in-practice" (Levina and Vaast, 2005), build on the ongoing interplay and confrontation between process design and process management. To some extent, design efforts, such as the introduction of flexible interface manager positions at MoTec, may support the emergence of interface management practice (see similar Garud *et al.* 2006)—by guiding local managers' attention to certain operational needs (Ocasio, 1997). At the same time, we pointed to the "functional aspect" of process design *deficiencies* in driving capability development. Although previous studies have focused on dangers of "design determinism" (e.g. Pentland and Feldman, 2008) or "overcodification" (Vaast and Levina, 2006), our study shows that design-related operational problems—here: the unpredicted ambiguity of mold design, testing, and other R&D support jobs—combined with internal performance pressure may not only drive processes of local experimentation by individual engineers and managers but, based on that, also promote a shift of organizational attention to process management issues. Rather than just realizing (and accepting) limitations of distributing knowledge work (see e.g. Brusoni, 2005), firms like MoTec may develop interface management and related capabilities in response to recurrent operational challenges that allow them to *enhance* their overall capacity of distributing—even under- or ill-specified—knowledge work. Our findings indicate that MoTec's centralized R&D network has facilitated this learning process, as it allowed for parallel local experimentation with interface management at R&D satellites (offshore facilities), and the realization of general principles of supporting effective interface management at the "center" (R&D headquarters), which regularly interacts with various offshore facilities.

Our findings may also inform the broader discourse on the emergence of organizational capabilities (Winter, 2000; Daneels *et al.*, 2002; Helfat and Lieberman, 2002; Ethiraj *et al.*, 2005), and, particularly, ongoing research on so-called "dynamic" capabilities in global operational contexts (Teece *et al.*, 1997; Eisenhardt and Martin, 2000; Zollo and Winter, 2002; Winter, 2003; Doh, 2005; Bingham and Eisenhardt, 2011). We argue that "interface management" as practiced at MoTec shows features of a dynamic capability. First, although it uses individual expertise and skills related to managing distributed work (see in general also Grant 1996a, b), it is more than just a set of individual skills. Key principles of interface management, such as the use of interface manager positions and network-based communication, have established and seem to get reproduced across locations at the organizational level. These principles get applied as sets of practices in various ways blending local conditions with global operational needs (Kostova, 1999). Second, managers and engineers do not just adopt but further experiment with practices of interface management. This has promoted continuous learning and adaptation processes across locations (see similar Gertler, 2003; Sapsed *et al.*, 2005)—an inherent quality of dynamic capabilities (Teece *et al.*, 1997; Zollo and Winter, 2002). Over time, globally shared principles of effective interface management have emerged and stimulated the introduction of open and flexible support structures, which are adapted in different and often changing local operational contexts (see in general Eisenhardt and Martin, 2000). For example, similar to the notion of "simple rules" (Eisenhardt and Martin, 2000), MoTec has introduced interface manager positions in terms of "open roles" guiding local managers' attention to the advantages of a designated staff person taking on interface management roles, without further specifying these roles. Instead, this position has served as a container for specific activities supporting local operational needs and processes (see also Winter, 2003).

Our study further indicates important factors driving the dynamics of capability development. First, it confirms the observation made by Bingham and Eisenhardt (2011) that organizations often learn in terms of heuristics, guided by processes of simplification and abstraction from concrete practice. In our case, MoTec senior managers derived principles of using "interface managers" and of establishing peer networks across units supporting the effective delivery of dispersed knowledge work from various experiments at different locations. Second, our study indicates that a rather centralized structure with different satellite units may facilitate parallel processes of local experimentation and global learning of core principles guiding the reproduction of dynamic capabilities. Third, our study demonstrates the performative effect of underspecified process designs in terms of eliciting experimentation. Similar to findings from Pentland and Feldman (2008), our case indicates that process (re-) designs stimulate the emergence of actor networks (e.g. involving engineers, subsidiary managers, internal clients, and particular tasks), which engage in various interactions to get things done. The introduction of new positions may thereby inform—rather than determine—such processes. Fourth, and relatedly, our study suggests that some dynamic capabilities, such as interface management, develop less around "routines" (see e.g. Dosi *et al.*, 2000; Winter, 2003) or "rules" (Eisenhardt and Martin, 2000), but about "relations," and the activation and nurturing of emergent individual expertise in interaction with others. This, of course, may increase reliance on individual skills to make dynamic capabilities work (Grant, 1996a, b; Teece *et al.*, 1997; Wang and Ahmed, 2007), but at the same time shift focus from particular activities and practices (Kostova, 1999; Szulanski, 1996) to the interaction context(s) within which individuals operate and get things done on behalf of the organization.

## 6. Some implications for managerial practice

Our study has important implications for the management of globally dispersed operations. First, it suggests that interfaces between globally distributed processes, in particular in the context of R&D and knowledge work, can only be "designed" ex-ante to a limited extent. Continuous management of interfaces is equally important. Second, interface managers can support the coordination of processes across locations. Their roles include gatekeeping and filtering of information, translating client demands to local staff, checking results before delivery to internal clients, etc. It seems important, however, to keep the role description open enough to allow local managers to "fill" the position based on their own expertise in response to local needs and conditions. Third, long-distance communication skills may increasingly complement technical and local team skills of engineers in contexts of distributed R&D. Personnel exchanges, network building, and cross-unit partnership structures may promote the development of such skills.

## 7. Limitations and conclusion

Our study also has some limitations, which need to be addressed in future research. First, we based our analysis on a single case of a German multinational automotive engineering firm. Future studies should compare interface management capabilities across firms in different industries. We expect differences by firm experience with globally distributing knowledge work. Also, high-tech firms may approach interface management different than service or low-tech manufacturing firms. Taking a comparative approach may facilitate a generalization in small steps (Diesing, 1971). Second, we focused mainly on nearshore R&D operations. We did not analyze the role of geographical and cultural distance in affecting the emergence of interface management capabilities. Cultural proximity may influence the ways in which interfaces are managed and/or the activities interface managers engage in (see also Vlaar *et al.*, 2008).

In conclusion, our study has analyzed interface management as an increasingly important organizational capability firms develop to manage globally dispersed knowledge work. Dynamic capability development builds on flexible global structural support of continuous local experimentation with interface management practices in response to operational challenges. Future studies are invited to further investigate the emergence of global capabilities supporting increasingly distributed operations.

## References

Aldrich, H. E. and D. Herker (1977), 'Boundary spanning roles and organizational structure,' *Academy of Management Review*, **2**(2), 217–230.

Apte, U. M. and R. O. Mason (1995), 'Global disaggregation of information-intensive services,' *Management Science*, **41**(7), 1250–1262.

Baldwin, C. Y. (2008), 'Where do transactions come from? Modularity, transactions, and the boundaries of firms,' *Industrial and Corporate Change*, **17**(1), 155–195.

Bardhan, A. D. and D. Jaffe (2005), *Innovation, R&D and Offshoring*. Fisher Center Research Reports, University of California: Berkeley.

Barley, S. R. (1996), 'Technicians in the workplace: ethnographic evidence for bringing work into organization studies,' *Administrative Science Quarterly*, **41**, 404–441.

Bechky, B. A. (2006), 'Gaffers, gofers, and grips: role-based coordination in temporary organizations,' *Organization Science*, **17**, 3–21.

Bingham, C. B. and K. M. Eisenhardt (2011), 'Rational heuristics: the "simple rules" that strategists learn from process experience,' *Strategic Management Journal*, **32**, 1437–1464.

Blinder, A. S. (2006), 'Offshoring: the next industrial revolution?' *Foreign Affairs*, **85**, 113–128.

Brusoni, S. A. Prencipe and K. L. R. Pavitt (2001), 'Knowledge specialization and the boundaries of the firm: why do firms know more than they make?,' *Administrative Science Quarterly*, **46**(4), 597–621.

Brusoni, S. (2005), 'The limits to specialization: problem solving and coordination in "modular networks",' *Organization Studies*, **26**, 1885–1907.

Brusoni, S., M. Jacobides and A. Prencipe (2009), 'Strategic dynamics in industry architectures and the challenges of knowledge integration,' *European Management Review*, **6**(4), 209–216.

Carlsson, B. (2006), 'Internationalization of innovation systems: a survey of the literature,' *Research Policy*, **35**, 56–67.

Clark, K. B. and T. Fujimoto (1991), *Product Development Performance: Strategy, Organization, and Management in the World Auto Industry*. Harvard Business School Press: Boston, MA.

Colovic, A. and U. Mayrhofer (2011), 'Optimizing the location of R&D and production activities: trends in the automotive industry,' *European Planning Studies*, **19**(8), 1481–1498.

Contractor, F. J., V. Kumar, S. K. Kundu and T. Pedersen (2010), 'Reconceptualizing the firm in a world of outsourcing and offshoring: the organizational and geographical relocation of high-value company functions,' *Journal of Management Studies*, **47**(8), 1417–1433.

Couto, V., M. Mani, V. Sehgal, A. Y. Lewin, S. Manning and J. W. Russell (2008), 'Offshoring 2.0: Contracting Knowledge And Innovation To Expand Global Capabilities, 2007 Service Provider Survey Report,' Booz and Duke University: Durham, NC.

Daneels, E. (2002), 'The dynamics of product innovation and firm competences,' *Strategic Management Journal*, **23**(12), 1095–1121.

Demirbag, M. and K. W. Glaister (2010), 'Factors determining offshore location choice for R&D projects: a comparative study of developed and emerging regions,' *Journal of Management Studies*, **47**(8), 1534–1560.

Dibbern, J., J. Winkler and A. Heinzl (2008), 'Explaining variations in client extra costs between software projects offshored to India,' *MIS Quarterly*, **32**, 333–366.

Diesing, P. (1971), *Patterns of Discovery in the Social Sciences*. Aldine-Atherton: Chicago.

Doh, J. P. (2005), 'Offshore outsourcing: implications for international business and strategic management theory and practice,' *Journal of Management Studies*, **42**, 695–704.

Dosi, G., R. R. Nelson and S. G. Winter (2000), 'Introduction: the nature and dynamics of organisational capabilities,' in G. Dosi, R. R. Nelson and S. G. Winter (eds), *The Nature and Dynamics of Organisational Capabilities*. Oxford University Press: Oxford, pp. 1–22.

Drucker, P. F. (1959), *Landmarks of Tomorrow*. Harper & Bros: New York.

Eisenhardt, K. M. (1989), 'Building theories from case study research,' *Academy of Management Review*, **14**, 532–550.

Eisenhardt, K. M. and J. A. Martin (2000), 'Dynamic capabilities: what are they?,' *Strategic Management Journal*, **21**, 1105–1121.

Ethiraj, S. K., P. Kale, M. S. Krishnan and J. V. Singh (2005), 'Where do capabilities come from and how do they matter? A study in the software services industry,' *Strategic Management Journal*, **26**(1), 25–45.

Feldman, M. S. (2000), 'Organizational routines as a source of continuous change,' *Organization Science*, **11**(6), 611–629.

Feldman, M. S. and B. T. Pentland (2003), 'Reconceptualizing organizational routines as a source of flexibility and change,' *Administrative Science Quarterly*, **48**(1), 94–118.

Florida, R. (1997), 'The globalization of R & D: results of a survey of foreign-affiliated R&D laboratories in the USA,' *Research Policy*, **26**, 85–103.

Friedman, T. (2005), *The World Is Flat: A Brief History of the 21st Century*. Penguin: London.

Garud, R., A. Kumaraswamy and V. Sambamurthy (2006), 'Emergent by design: performance and transformation at infosys technologies,' *Organization Science*, **17**, 277–286.

Gassmann, O. and Z. Han (2004), '*Motivations and barriers of foreign R&D activities in China.*' *R&D Management*, Vol. 34, pp. 423–437.

Gertler, M. S. (1995), ' "Being there": proximity, organization, and culture in the development and adoption of advanced manufacturing technologies,' *Economic Geography*, **71**, 1–26.

Gertler, M. S. (2003), 'Tacit knowledge and the economic geography of context, or The undefinable tacitness of being (there),' *Journal of Economic Geography*, **3**, 75–99.

Gerybadze, A. and G. Reger (1999), 'Globalization of R&D: recent changes in the management of innovation in transnational corporations,' *Research Policy*, **28**, 251–274.

Grant, R. M. (1991), 'The resource-based theory of competitive advantage: implications for strategy formulation,' *California Management Review*, **33**, 114–135.

Grant, R. M. (1996a), 'Prospering in dynamically-competitive environments: organizational capability as knowledge integration,' *Organization Science*, **7**(4), 375–387.

Grant, R. M. (1996b), 'Toward a knowledge-based theory of the firm,' *Strategic Management Journal*, **17**(Winter special issue), 109–122.

Grimaldi, R., E. Mattarelli, A. Prencipe and M. Von Zedtwitz (2010), 'Offshoring of Intangibles: organizational and strategic issues,' *Industry and Innovation*, **17**, 331–336.

Harada, T. (2003), 'Three steps in knowledge communication: the emergence of knowledge transformers,' *Research Policy*, **32**, 1737–1751.

Harryson, S. J. (1997), 'How Canon and Sony drive product innovation through networking and application-focused R&D,' *Journal of Product Innovation Management*, **14**, 288–295.

Heijmen, T., A. Y. Lewin, S. Manning, N. Perm-Ajchariyawong and J. W. Russell (2009), 'Offshoring Reaches the C-Suite. 2007/8 ORN Survey Report,' Duke University & The Conference Board: Durham, NC.

Helfat, C. E. and M. B. Lieberman (2002), 'The birth of capabilities: market entry and the importance of pre-history,' *Industrial and Corporate Change*, **11**, 725–760.

Helper, S. and S. Khambete (2005), 'Off-shoring, interfaces, and collaboration across the supply chain: a case study in automotive product development,' *IMVP Working Paper*, Boston, MA.

Hobday, M., A. Davies and A. Prencipe (2005), 'Systems integration: a core competence of modern corporation,' *Industrial and Corporate Change*, **14**, 1109–1143.

Jensen, M. B., B. Johnson, E. Lorenz and B. A. Lundvall (2007), 'Forms of knowledge and modes of innovation,' *Research Policy*, **36**, 680–693.

Jensen, P. D. Ø. (2009), 'A learning perspective on advanced services offshoring,' *Journal of International Management*, **15**, 181–193.

Jensen, P. D. Ø. and T. Pedersen (2011), 'The economic geography of offshoring: the fit between activities and local context,' *Journal of Management Studies*, **48**, 352–372.

Jensen, P. D. Ø. (2012), 'A passage to India: a dual case study of activities, processes and resources in offshore outsourcing of advanced services,' *Journal of World Business*, **47**, 311–326.

Kenney, M., S. Massini and T. P. Murtha (2009), 'Offshoring administrative and technical work: new fields for understanding the global enterprise,' *Journal of International Business Studies*, **40**(6), 887–900.

Kogut, B. and U. Zander (1992), 'Knowledge of the firm, combinative capabilities, and the replication of technology,' *Organization Science*, **3**, 383–397.

Kotabe, M. and K. S. Swan (1994), 'Offshore sourcing: reaction, maturation, and consolidation of U.S. multinationals,' *Journal of International Business Studies*, **25**, 115–140.

Kostova, T. (1999), 'Transnational transfer of strategic organizational practices: a contextual perspective,' *Academy of Management Review*, **24**, 308–324.

Kumar, K., P. C. van Fenema and M. A. von Glinow (2009), 'Offshoring and global distribution of work: implications for task interdependence theory and practice,' *Journal of International Business Studies*, **40**, 642–667.

Kuemmerle, W. (1999), 'The drivers of foreign direct investment into research and development: an empirical investigation,' *Journal of International Business Studies*, **30**(1), 1–24.

Larsen, M. M., S. Manning and T. Pedersen (2013), 'Uncovering the hidden costs of offshoring: the interplay of complexity, organizational design and experience,' *Strategic Management Journal,* Forthcoming.

Leonardi, P. M. and D. E. Bailey (2008), 'Transformational technologies and the creation of new work practices: making implicit knowledge explicit in task-based offshoring,' *MIS Quarterly*, **32**, 411–436.

Levina, N. and E. Vaast (2005), 'The emergence of boundary spanning competence in practice: implications for implementation and use of information systems,' *MIS Quarterly*, **29**(2), 335–363.

Levina, N. and E. Vaast (2008), 'Innovating or doing as told? Status differences and overlapping boundaries in offshore collaboration,' *MIS Quarterly*, **32**, 307–332.

Lewin, A. Y. and V. Couto (2007), 'Next Generation Offshoring: the Globalization of Innovation, Duke University CIBER/Booz Allen Hamilton Report,' Durham.

Lewin, A. Y., S. Massini and C. Peeters (2009), 'Why are companies offshoring innovation? The emerging global race for talent,' *Journal of International Business Studies*, **40**(6), 901–925.

Malecki, E. J. (2010), 'Global knowledge and creativity: new challenges for firms and regions,' *Regional Studies*, **44**(8), 1033–1052.

Mani, D., A. Barua and A. B. Whinston (2010), 'An empirical analysis of the impact of information capabilities design on business process outsourcing performance,' *MIS Quarterly*, **34**(1), 39–62.

Manning, S. (2012), 'New Silicon Valleys or a new species? Commoditization of knowledge work and the rise of knowledge services clusters,' *Research Policy*, (forthcoming).

Manning, S., S. Massini and A. Y. Lewin (2008), 'A dynamic perspective on next-generation offshoring: the global sourcing of science & engineering talent,' *Academy of Management Perspectives*, **22**, 35–54.

Manning, S., J. Sydow and A. Windeler (2012), 'Securing access to lower-cost talent globally: the dynamics of active embedding and field structuration,' *Regional Studies*, **46**, 1201–1218.

Maskell, P., J. Dick-Nielsen, T. Pedersen and B. Petersen (2007), 'Learning paths to global offshore outsourcing – from cost reduction to knowledge seeking,' *Industry and Innovation*, **14**(3), 239–257.

Massini, S., N. Perm-Ajchariyawong and A. Y. Lewin (2010), 'Role of corporate wide offshoring strategy in directing attention to offshoring drivers, risks and performance,' *Industry and Innovation*, **17**(4), 337–371.

Mattarelli, E. and M. R. Tagliaventi (2010), 'Work-related identities, virtual work acceptance and the development of glocalized work practices in globally distributed teams,' *Industry and Innovation*, **17**(4), 415–443.

McDonough, E. F., K. B. Kahn and A. Griffin (1999), 'Managing communication in global product development teams,' *IEEE Transactions on Engineering Management*, **46**, 375–386.

Metters, R. and R. Verma (2008), 'History of offshoring knowledge services,' *Journal of Operations Management*, **26**, 141–147.

Mithas, S. and J. Whitaker (2007), 'Is the world flat or spiky? Information intensity, skills, and global service disaggregation,' *Information Systems Research*, **18**(3), 237–259.

Mudambi, S. and S. Tallman (2010), 'Make, buy or ally? Theoretical perspectives on knowledge process outsourcing through alliances,' *Journal of Management Studies*, **47**(8), 1434–1456.

Nelson, R. N. and S. G. Winter (1982), *An Evolutionary Theory of Economic Change*. Harvard University Press: Harvard, MA.

Nickerson, J. A. and T. R. Zenger (2004), 'A knowledge-based theory of the firm—the problem-solving perspective,' *Organization Science*, **15**, 617–632.

Ocasio, W. (1997), 'Towards an attention-based view of the firm,' *Strategic Management Journal*, **18**(Summer Special Issue), 187–206.

O'Leary, M. B. and N. J. Cummings (2007), 'The spatial, temporal, and configurational characteristics of geographic dispersion in teams,' *MIS Quarterly*, **31**, 433–452.

O'Mahony, S. and B. A. Bechky (2008), 'Boundary organizations: enabling collaboration among unexpected allies,' *Administrative Science Quarterly*, **53**, 422–459.

Penrose, E. (1959), *The Growth of The Firm*. Oxford University Press: Oxford, UK and New York, NY.

Pentland, B. T. and M. S. Feldman (2008), 'Designing routines: on the folly of designing artifacts, while hoping for patterns of action,' *Information & Organization*, **18**(4), 235–250.

Pratt, M. G. (2009), 'From the editors: for the lack of a boilerplate: tips on writing up (and reviewing) qualitative research,' *Academy of Management Journal*, **52**(5), 856–862.

Prencipe, A., A. Davies and M. Hobday (2003), *The Business of Systems Integration*. Oxford University Press: Oxford.

Reich, R. B. (2001), *The Future of Success*. Alfred A. Knopf, New York, NY.

Santos, J., Y. Doz and P. Williamson (2004), 'Is your innovation process global?,' *MIT Sloan Management Review*, **45**(4), 31–37.

Sapsed, J., D. Gann, N. Marshall and A. Salter (2005), 'From here to eternity?: the practice of knowledge transfer in dispersed and co-located project organizations,' *European Planning Studies*, **13**, 831–851.

Sen, A. K. (2009), 'Outsourcing of research and development activities: evidence from U.S. biopharmaceutical firms,' *Global Journal of Business Research*, **3**(1), 73–82.

Sinha, K. K. and A. H. Van de Ven (2005), 'Designing work within and between organizations,' *Organization Science*, **16**, 389–408.

Sobek, D. K., J. K. Liker and A. C. Ward (1998), 'Another look at how Toyota integrates product development,' *Harvard Business Review*, **76**(4), 36–49.

Srikanth, K. and P. Puranam (2011), 'Integrating distributed work: comparing task design, communication, and tacit coordination mechanisms,' *Strategic Management Journal*, **32**(8), 849–875.

Stringfellow, A., M. B. Teagarden and W. Nie (2008), 'Invisible costs in offshoring services work,' *Journal of Operations Management*, **26**(2), 164–179.

Sturgeon, T. J., J. Van Biesebroeck and G. Gereffi (2008), 'Value chains, networks and clusters: reframing the global automotive industry,' *Journal of Economic Geography*, **8**(3), 297–321.

Szulanski, G. (1996), 'Exploring internal stickiness: impediments to the transfer of best practice within the firm,' *Strategic Management Journal*, **17**(Special Issue), 27–43.

Teece, D. J., G. Pisano and A. Shuan (1997), 'Dynamic capabilities and strategic management,' *Strategic Management Journal*, **18**, 509–533.

Tsoukas, H. and R. Chia (2002), 'On organizational becoming: rethinking organizational change,' *Organization Science*, **13**(5), 567–582.

Vaast, E. and N. Levina (2006), 'Multiple faces of codification: organizational redesign in an IT organization,' *Organization Science*, **17**(2), 190–201.

Vlaar, P. W. L., P. C. van Fenema and V. Tiwari (2008), 'Cocreating understanding and value in distributed work: how members of onsite and offshore vendor teams give, make, demand, and break sense,' *MIS Quarterly*, **32**, 227–255.

Von Zedtwitz, M., O. Gassmann and R. Boutellier (2004), 'Organizing global R&D: challenges and dilemmas,' *Journal of International Management*, **10**(1), 21–49.

Wang, C. L. and P. K. Ahmed (2007), 'Dynamic capabilities: a review and research agenda,' *International Journal of Management Reviews*, **9**, 31–51.

Winter, S. G. (2000), 'The satisficing principle in capability learning,' *Strategic Management Journal*, **21**, 981–996.

Winter, S. G. (2003), 'Understanding dynamic capabilities,' *Strategic Management Journal*, **24**, 991–995.

Yin, R. K. (2003), *Case Study Research: Design and Methods*. Sage: Thousand Oaks.

Zollo, M. and S. G. Winter (2002), 'Deliberate learning and the evolution of dynamic capabilities,' *Organization Science*, **13**, 339–351.