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**Emerging Capability or Continuous Challenge?
Relocating Knowledge Work and Managing Process Interfaces**

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Abstract

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, and the role of local experimentation, centralized global learning and flexible structural support for dynamic global capability development.

Key Words

Research and development, engineering, offshoring, interfaces, task intermediation, learning, dynamic capability, emergence and design

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Introduction

Organization scholars have long been interested in the coordination of geographically distributed knowledge work, e.g. research and development (R&D) (Gertler, 2003; Sapsed et al., 2005; Von Zedtwitz et al., 2004). 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 activities 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 & Van de Ven, 2005; Blinder, 2006; Mani et al., 2010). However, due to the partial tacitness of knowledge work, tasks and interfaces are often not fully specifiable which may result in process and interface ambiguities (Brusoni, 2005; Gertler, 2003). 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 & Khambete, 2005), but offshoring of knowledge work can be increasingly observed across manufacturing and

even service industries (see e.g. Lewin & 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 U.S and European firms increasingly source knowledge work from abroad in support of domestic and global operations (Lewin et al., 2009; Manning et al., 2008; Demirbag & Glaister, 2010; Jensen & Pedersen, 2011; Kenney et al., 2009). 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 & Mason, 1995; Mithas & Whitaker, 2007). However, recent studies also indicate that firms face continuous challenges not only related to protection of intellectual property (see e.g. Bardhan & Jaffee, 2005; Gassmann & Han, 2004), 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 & Vaast, 2008; Vlaar et al., 2008; Srikanth & 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 can be developed 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 (Clark & Fujimoto, 1991; Kotabe & Swan, 1994; Sobek et al., 1998; Sturgeon et al., 2008), as well as an emerging stream of micro-level research on offshore implementation practices (Levina & Vaast, 2008; Vlaar et al., 2008; Srikanth & 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 prior to 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 & Chia, 2002; Garud et al., 2006; Pentland & 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 prior to relocating them.

Our findings contribute, on the one hand, to the ongoing literature on distributing knowledge work (Gertler, 2003; Sapsed et al., 2005; Hobday et al., 2005; Prencipe et al., 2003) 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 prior to relocating knowledge work (e.g. Mithas & Whitaker, 2007; Sinha & Van de Ven, 2005), or the challenges in doing so, given the complexity and intangibility of knowledge work (e.g. Brusoni, 2005; Mudambi & 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 & 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 & 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 & 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.

Sapsed et al., 2005; Gertler, 1995; Vaast & Levina, 2006), 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 & Bailey, 2008); the development of trust and identity between geographically separated operations (e.g. Levina & Vaast, 2008; Mattarelli & Tagliaventi, 2010); the interpretation of tasks (e.g. Vlaar et al., 2008; Harada, 2003); communication between offshore and headquarter operations (e.g. Harada, 2003; Sobek et al., 1998; Levina & Vaast, 2005); and the establishment of peer contacts across locations (e.g. Jensen et al., 2007; Gertler, 2003).

Other studies specifically focus on the *organizational* level: While some authors are skeptical about the effectiveness of organizational measures in facilitating interface management – e.g. Levina & Vaast (2005) note that formal boundary spanners 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 & 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 (Helfat & Lieberman, 2002; Penrose, 1959). Organizational capabilities can be to some extent emergent (Zollo & Winter, 2002; Kogut & Zander, 1992), but they typically also follow – or are nurtured by – strategic intentions (Dosi et al. 2000; Grant, 1991). 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 & Winter, 1982; Winter, 2003; Grant, 1991). However, in order 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 & 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 & Martin, 2000; Bingham & 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 (Wang & Ahmed, 2007; Feldman, 2000; Feldman & Pentland, 2003), but whose knowledge needs to be integrated, to some degree, within routines and capabilities themselves in order for the latter to be effective and adaptable (Grant, 1996a, 1996b).

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 (Kumar et al., 2009; Levina & Vaast, 2005). 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 & Winter, 2002; Nickerson & Zenger, 2004). As mentioned above, 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 prior to 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.

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 & Fujimoto, 1991; Kotabe & Swan, 1994; Sturgeon et al., 2008; Manning et al., 2011; Colovic & Mayrhofer, 2011). Whereas 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 utilized 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 & Khambete, 2005; Manning et al., 2011). For this study we

selected the Germany-based automotive engineering firm MoTec which has set up both market-driven hubs in the U.S. 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. Helper & Khambete, 2005; Sobek et al., 1998). Sobek et al., (1998), for example, list, based on the example of Toyota, key organizational practices, such as process standards and cross-functional coordination, that 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.

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 & 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 & Vaast, 2008; Vlaar et al., 2008; Jensen, 2012). Case studies are particularly valuable for investigating complex social processes which cannot be easily

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. While 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 U.S.

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.

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 & Feldman, 2008). This notion has some similarities with the idea of processes and structures being partly ‘designed’, partly ‘emergent’ (see e.g. Levina & 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). Whereas (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.

(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 were 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. 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 more personal means of communication. The following quote underlines this rationale with respect to mold design:

(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 in order to be understood. This process of discussing and 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, as well as 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 since 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 the ex-ante process design and to continuous interface management.

(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 since 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 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)

One important facilitating factor in this process has been the centralization of core R&D in Hanover. While 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 headquarter. This structural set-up 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 have been centralized training measures in Hanover. Whereas 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.

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 prior to 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 (Brusoni, 2005; Gertler, 2003; Leonardi & 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 Mithas & Whitaker, 2007; Sinha & Van de Ven, 2005). However, as knowledge work gets located, firms – again like MoTec – often experience rather unexpected process and interface ambiguities due 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 & 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.

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 (Sapsed et al., 2005; Gertler, 2003; Harada, 2003). 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; Jensen et al., 2007; Sobek et al., 1998). 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 & 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. Whereas previous studies have focused on dangers of ‘design determinism’ (e.g. Pentland & Feldman, 2008) or ‘overcodification’ (Vaast & 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 (Ethiraj et al., 2005; Helfat and Lieberman, 2002; Daneels et al., 2002), and, particularly, ongoing research on so-called ‘dynamic’ capabilities in global operational contexts (Teece et al., 1997; Eisenhardt & Martin, 2000; Zollo & Winter, 2002; Winter, 2003; Bingham & Eisenhardt, 2011; Doh, 2005). We argue that ‘interface management’ as practiced at MoTec shows features of a dynamic capability. First, although it utilizes individual expertise and skills related to managing distributing work (see in general also Grant 1996a, 1996b), 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 & 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 & Martin, 2000). For example, similar to the notion of ‘simple rules’ (Eisenhardt & 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, 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, our study suggests that some dynamic capabilities, such as interface management, develop less around ‘routines’ (see e.g. Winter, 2003; Dosi et al., 2000) or ‘rules’ (Eisenhardt & 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, 1996b; Teece et al., 1997; Wang & 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.

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.

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 in order 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.

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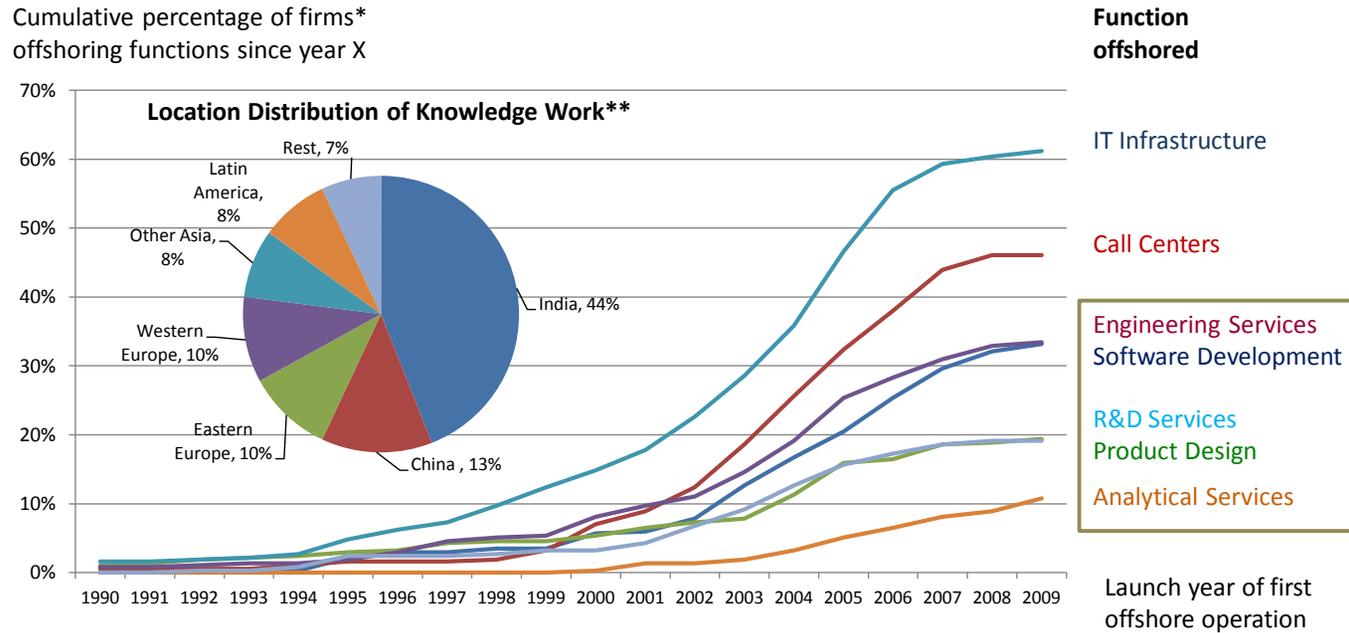
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Appendix: Figures and Tables

Figure 1: The Growing Trend of Offshoring Knowledge Work*



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

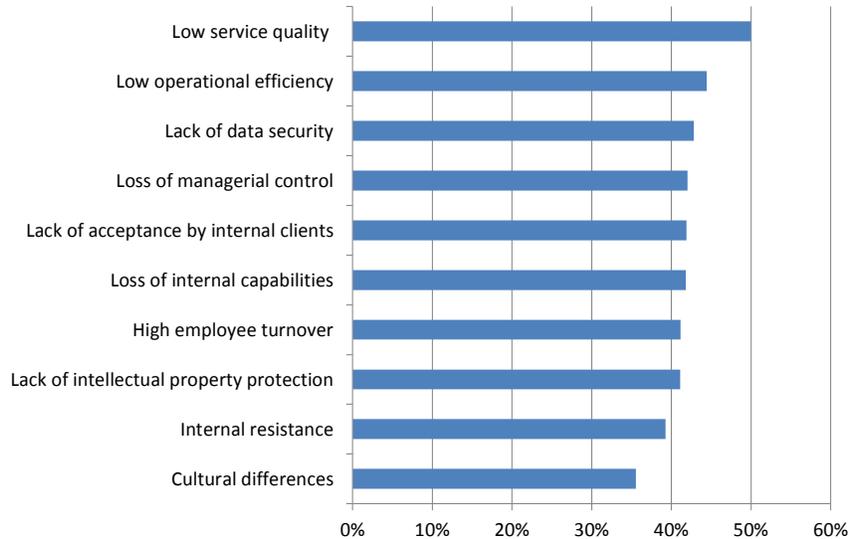
* Percentage of U.S. and European firms (n=371) reporting offshoring projects in ORN database (based on launch years)

** Percentage of concrete implementations (n=1020) sourced from particular regions (ORN database)

*See for similar charts based on ORN data Lewin & Couto (2007), Heijmen et al., (2009)

Figure 2: Challenges Related to Relocating Knowledge Work *

Important challenges as perceived by firms offshoring knowledge work*
 (Percentage of firms perceiving challenge as important – based on 5-point Likert scale, % responses 4 or 5)



* Data is 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)

*See for similar charts based on ORN data Lewin & Couto (2007), Heijmen et al., (2009)

Figure 3: Development of Interface Management Capabilities

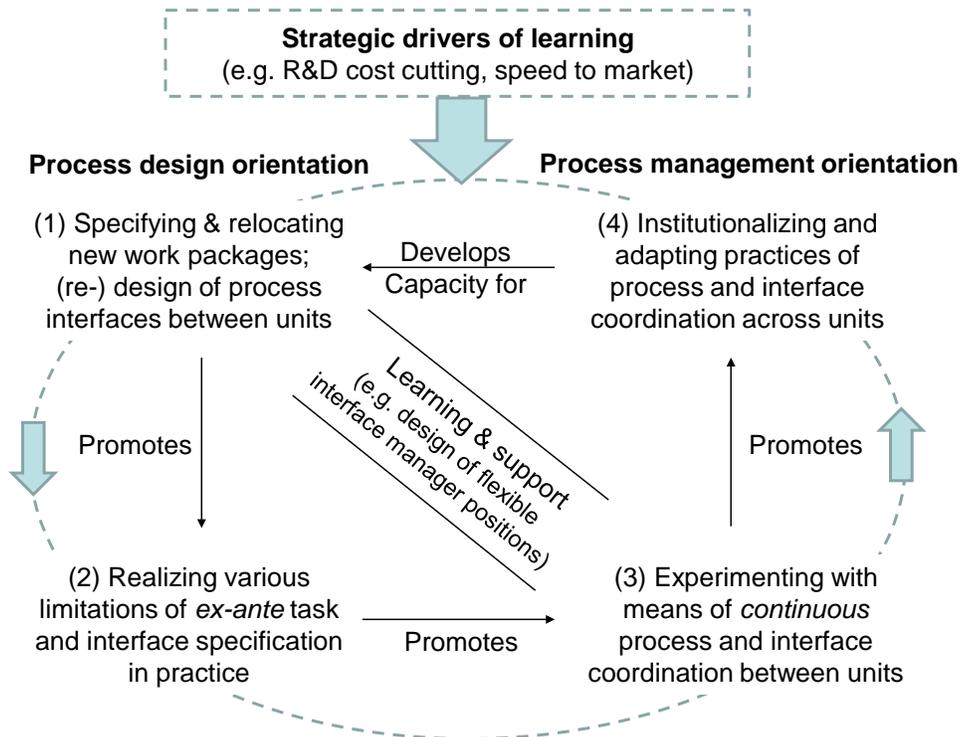


Table 1: List of Interviews

No.	Position/responsibility	Date	Length	Location
1	Head of R&D BU A2	21/05/07	65'	Phone call
2	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 & Safety Systems	22/05/07	90'	Germany
8	VP Strategic Projects BU B	29/05/07	60'	Phone call
9	Manager Product Review and QM R&D	05/06/07	60'	Phone call
10	Head of HR 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	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
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 & 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 OE 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'	

Table 2: List of MoTec R&D Locations

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 1,000 employees in R&D (PLT and CVT)	1/3 in testing, 2/3 in R&D			
Hanover, Germany	Excerpts: 43 employees in CVT technology development, 20 in product line development, 20 in Mold Design, 65 in Material Evaluation, 100 in Testing Details	Basic development for PLT (90% of all R&D in Europe) and CVT (over 90% of all R&D); 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 Hannover, Germany	Appr. 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	Appr. 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
Acron, USA	Closed	R&D	Acquisition; 1987		Closed 1996

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)
Mount Vernon, USA	Appr. 25 employees	CVT, application engineering for local market, responsibility for big tires, mold design	Acquisition; 1987	Basic CVT development in Hanover; only loose ties as CVT tires significantly different in the US; marketing requirements from Charlotte; mold design deals exclusively with Hanover	Hanover has tighten ties in the last years; before completely independent
Auburn Hills, USA	Appr. 40 employess (thereof 4 employees for mold design)	Technology development and adjustments for local customers (application engineering primary business), KAM, NVH engineering, mold design, testing, interface management	R&D established 2001/2002 to be nearer to US customers	Basic PLT development in Hannover (2 dedicated interface managers); testing also for Charlotte and Mount Vernon; interfaces to external customers managed by automotive engineers	Primary business 2002 transferred from Charlotte
Uvalde, USA	15-30 employees (incl. temporary empl.)	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 Hannover	Significant capacity reduction during the last 10 years (originally 160 employees)
Timisoara, Romania	12-15 employees	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

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)
Puchov, Slovakia	Appr. 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 (CVT)
Otrokovice, Czech Republic	Appr. 50 employees (thereof 14 Material Evaluation)	Material tests, mold design (industrial tires, replacement business PLT), machine testing	Acquisition; 1993, green field approach for PLT 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	Appr. 30 employees	Machine testing and local development (product line development replacement); Trend Scout; Material Evaluation for natural ingredients; all F&E activities for Asia	Joint venture; 2003	Only interfaces to Hanover	Another unit for China planned (in China for local application engineering)

Table 3: Realizing the Tension: The Limitations of Task and Interface Design

Tensions	(1) Specifying and relocating work packages; (re-) design of process interfaces	(2) Realizing various limitations of task and interface specification in practice
Need to identify tasks and related skills VS. actual ambiguity of task specifications	<p>“What we have done is to define whole work packages which can then be transferred to a particular location.” (Director Material and Simulation)</p> <p>"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)</p> <p>"The rule is to concentrate as much in one location in order to increase efficiency.” (Director External Communication)</p>	<p>"...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)</p> <p>"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)</p>
Minimizing interfaces VS. realizing need for continuous coordination	<p>"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)</p> <p>"You need to analyze each service and then fine-slice it and bring it back together." (HR IT)</p>	<p>"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)</p> <p>“...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)</p>

Table 4: Managing the Tension: Emerging Interface Management Capabilities

Dimension	(3) Experimenting with various means of process and interface coordination between particular units	(4) Institutionalizing and adapting practices of process and interface coordination across units
Establishing Interface Management Practices	<p>"We compensate the spatial distance to technology development through accompanying processes which involve intensive communication and exchange." (U.S. Director Product Development)</p> <p>"[...] 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)</p>	<p>"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)</p> <p>"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)</p>
Building Lateral Ties between Units	<p>"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)</p> <p>"Because of established contacts here in Hanover both partners now use telephone more often which helps enhance exchange." (Supervisor Simulations, Romania)</p>	<p>"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)</p> <p>"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)</p>