Journal of International Business Studies (2009) 40, 642–667

www.jibs.net

Offshoring and the global distribution of work: Implications for task interdependence theory and practice

Kuldeep Kumar[1,2,3], Paul C van Fenema[4,5] and Mary Ann von Glinow[6]

[1]GDW Foundation, Bangalore, India; [2]Department of IS, City University of Hong Kong, Hong Kong; [3]DSIS Department, Florida International University, Miami, USA; [4]Netherlands Defense Academy, The Netherlands; [5]Tilburg University, The Netherlands; [6]College of Business Administration, Florida International University, Miami, USA

Correspondence:
PC van Fenema,
Netherlands Defense Academy,
Faculty of Military Sciences,
Section Management,
Organization and Defense Economy,
PO Box 90002, Breda NL-4800 PA,
The Netherlands.
Tel: +31 76 5273878;
Fax: +31 76 5273255

Received: 19 January 2007
Revised: 15 January 2008
Accepted: 28 January 2008
Online publication date: 30 October 2008

Abstract

A recent Offshoring Research Network (ORN) global survey of offshoring shows that since 2004 management concerns about operational issues on achieving the benefits of offshoring have increased significantly. In this paper we examine inter-task interdependence, a key operational determinant of inter-site interaction and communications in offshoring. We analyze existing theories of interdependence to examine the extent to which they provide guidance for understanding the interaction and communication requirements between work segments that are offshored and distributed across the globe. Using a series of mini-cases on globally distributed work (GDW), we show how the traditional typology of interdependence developed in the 1960s and 1970s is no longer adequate for understanding and managing task interdependencies in GDW. We propose three concepts to address this problem: integration interdependence, "hand-offs", and information "stickiness". We then show how our revised typology of interdependence enables a better understanding of the interactions and communication requirements between sites. Using this revised theory we propose guidelines for work design, and examine their implications for practical offshoring and work-distribution decisions. Implications for theory and practice for MNEs engaged in offshore relationships are discussed.

Journal of International Business Studies (2009) **40,** 642–667.
doi:10.1057/jibs.2008.77

Keywords: offshoring; organization theory; control and coordination mechanisms; globally distributed work; task interdependence; multinational enterprises

INTRODUCTION

"Offshoring refers to the process by which companies undertake some activities at offshore locations instead of their countries of origin" (Murtha, Kenney, & Massini, 2006). It includes transferring some of the company's work to offshore outsourcing vendors, as well as to captive subsidiaries and divisions of the company located offshore (Carmel & Tjia, 2005; Kaiser & Hawk, 2004). Offshoring is a special case of the more general concept of global distribution of work (Kumar, van Fenema, & Von Glinow, 2005; Lewin & Peeters, 2006a, b; Shapiro, Von Glinow, & Cheng, 2005). However, given the popularity of the term "offshoring", we continue to interchangeably use the two terms: the specialized term "offshoring," and the more general term "global distribution of work (GDW)".[1]

Examples of offshoring and globally distributed work (GDW) in international business (IB) include global supply chains (where either the whole product, or parts of the product, are manufactured at offshore or globally distributed locations), offshore or global software development, offshore business and knowledge process outsourcing, globalized services, offshoring and globalization of R&D (Mohrman, Klein, & Finegold, 2003). Indeed, most multinational enterprises, by definition, have elements of GDW, since the global sourcing for manpower, talent, and intellectual capital knows no boundaries. The trend towards global distribution of work can now also be found in e-science, medicine, cinema, and a host of other disciplines (Shapiro et al., 2005; Von Glinow, Drost, & Teagarden, 2005; Von Glinow, Shapiro, & Brett, 2004). For our purposes here, we discuss GDW in the context of IB and how work design needs fundamental rethinking to meet the challenges of today's global realities.

The underlying motivation of this paper is to examine current theories of work design to determine whether they are sufficiently robust to provide guidance for addressing operational level and work design issues in global distribution of work. Since GDW requires that work be partitioned and distributed across globally distributed locations, our focus is the investigation of current theoretical conceptualization of a key work design concept, *inter-task interdependence* between partitioned work segments or tasks, to determine its adequacy in understanding and designing operational aspects of work distribution. We first establish the rationale for taking an operational work design perspective for the design of GDW. Next, we examine the adequacy of the classic interdependence typology to explain work patterns in the context of globally distributed information and knowledge-intensive complex work. We subsequently establish that the classic typology of interdependence, while adequate for explaining traditional work patterns for collocated, simple, physical production work, does not explain work patterns with intense interactions between actors and work sites in both transactional (sequential and reciprocal) and parallel work in globally distributed, knowledge-intensive work environments common to offshoring. To address these shortcomings we introduce three concepts – integration interdependence, hand-offs, and stickiness – to develop an extended typology of interdependence. The extended typology then models the consequences of transitioning from collocated to globally distributed offshored work. Using this model of distributed work we highlight stickiness, both in work hand-offs and in parallel work, as a key concept differentiating interdependencies in GDW. Next, we propose a set of guidelines for avoiding, reducing, and enabling sticky interdependencies. Finally, we use these guidelines in analyzing two typical offshoring decisions, namely the decision to offshore R&D, and the decision about the choice of offshoring destination. Our analysis shows that this finer-grained revised typology of interdependence, by providing a better understanding of offshoring decisions, provides important contributions to both research and practice in IB.

Challenges of Work Design: An Operational Level Perspective

GDW, or offshoring, can be examined at both the strategic and the operational level. At the strategic level, firms evaluate the reasons for and risks of distributing work at global distances; investigate the investment, resources, governance, cultural, infrastructure, and regulatory issues and questions associated with global work; and in broad terms decide what parts of the work cycle to move offshore, and when and where to move it (Lewin & Peeters, 2006a). After the initial euphoria of anticipated cost reductions, increased access to human resources, or increased potential for innovation has subsided, these strategic offshoring decisions still have to be implemented and executed (operational level). It is at this level that the company's managers focus on the actual process of work distribution – the minutiae of exactly which parts of work activities to keep colocated and which to distribute to foreign locations, and to ensure that the outcomes of the distributed work can be integrated smoothly to produce its products or services. In today's dynamic business environment managers are expected to monitor work division and integration continuously, rather than consider these issues as one-off design and decision problems. It is how well managers manage the "mechanics" of these ongoing operational processes of partitioning, moving, and managing distributed work that can determine the success or failure of the offshoring decision (Couto, Mani, Lewin, & Peeters, 2006).

The recent professional literature is replete with reports of companies that have retreated from offshoring, because after the strategic decision to offshore, either the initially projected benefits are not realized during implementation, or the operational problems and costs of work transfer, intersite communication, and coordination outweigh the forecast savings and benefits. A 2006 Duke/Booz Allen Hamilton Offshoring Research Network (ORN) global survey of offshoring in public and private sector organizations shows that, since 2004, management concerns about operational issues such as operational efficiency, loss of managerial control, service quality, and data security have increased significantly (Exhibit 7, Couto et al., 2006: 8). For executives considering the offshoring decision, the problem lies in a lack of management expertise, appropriate operating procedures, and management models needed to implement offshoring work distribution at an *operational* level. Therefore, if the projected strategic benefits of offshoring and GDW are to be realized, it is important that we examine operational aspects of offshored work and identify ways of managing these concerns.

Consequently, we focus on the operational aspects of offshoring, and in particular the role of work interdependencies between distributed sites, that drive their communication, coordination, and management requirements (Adler, 1995; Crowston, 1997; Malone, Crowston, Lee, & Pentland, 1999). When work is segmented and distributed across work sites, the ways in which the distributed work segments depend upon one another determine the interactions, communication, coordination, and control requirements between distributed work sites. Thus it is imperative that we examine intersite interdependencies in order to understand the interaction, communication, coordination, and management requirements.

Task Interdependence in Offshoring

The starting point of any work design, including the design of globally distributed or offshored work, is the differentiation of work into tasks, sub-tasks, and activities that can be assigned to various actors,[2] some of whom are located on site and others offshore at global distances. Subsequently, the outcomes of these differentiated and distributed tasks need to be brought together, or integrated to produce the intended product or service (Carmel, 1999). Given that these partitioned tasks and sub-tasks are part of the overall work of the organization, and ultimately contribute to organizational performance, they are interdependent. Interdependence between two tasks is the extent to which the performance and outcome of one task is affected by, or needs interaction with, the performance and outcome of other tasks (Crowston, 1997; Purser & Montuori, 1995; Victor & Blackburn, 1987; Wageman, 1995). Depending upon how work is partitioned, the segmented and globally distributed sub-tasks and activities may be performed either more or less independently from each other. Literature suggests that the greater the interdependence between tasks, the greater the amount of communication and coordination effort required, the greater the chance of breakdown, and the greater the likelihood of loss of control, especially when tasks are located across global distances (Cramton, 2001; Kumar et al., 2005; Kurland & Egan, 1999; Nemiro, 2000; Thompson, 1967; Weisband, 2002). Thus it is essential to examine and understand the implications of task interdependence in designing the global distribution of offshored work.[3]

Current Research on Interdependence and Challenges for IB Research

With the exception of Bell and Kozlowski (2002), research on interdependence does not take into account the physical location of work and actors. On the other hand, as organizations become increasingly globally dispersed, the partitioning and allocation of work to globally dispersed sites, and its subsequent integration, become critical in work design as well as in overall performance. The classic conceptualization of task interdependence (McCann & Galbraith, 1981; Thompson, 1967; Van de Ven, Delbecq, & Koenig, 1976) has been useful in addressing a variety of questions related to organizational design. Nevertheless, for three interrelated reasons we believe the classic typology of interdependence needs rethinking to be useful for IB researchers interested in, and managers responsible, for the offshoring decision. These three reasons are: globalization and its impact on interactor communication; the shift to information and knowledge work; and increasing product complexity.

Globalization and gaps in inter-actor communication. Traditional concepts of task interdependence and its theoretical frameworks were developed in the 1960s and 1970s, primarily in the context of collocated, physical manufacturing work, or well-defined clerical work (Burns & Stalker, 1961; Parsons, 1956a, b; Stinchcombe, 1959; Thompson, 1967; Van de Ven et al., 1976). Physical proximity made it possible for the participants in the work case, for example on a factory or office floor, to observe each other continuously and directly, monitor the state of the work object (i.e., the part or object being worked at, or the document being processed), as well as observe the other party's actions and outcomes with respect to it, and, synchronously and in real time, communicate and mutually adjust with the other actors face to face (Herbsleb & Mockus, 2003).

Transitioning from collocated to GDW introduces a number of gaps that create impediments to inter-task and inter-actor observation and communication (Abel, 1990; Allen, 1984). Because of physical distance, it is no longer possible for actors to directly observe each other's task performance and outcomes (Nemiro, 2000). Moreover, because of time gaps, geographically dispersed actors need explicit synchronization effort to communicate with each other, or communicate asynchronously. Furthermore, differences in context-dependent meanings between dispersed and culturally diverse work sites (culture gaps) make it even more difficult to communicate, necessitating explicit, frequent, and intense back-and-forth communication to achieve common understanding across actors from diverse cultures (Meadows, 1996a, b; Rottman & Lacity, 2006). Global distances cause breakdowns in face-to-face interactions and mutual adjustment processes that previously sustained collocated coordination processes (Herbsleb & Mockus, 2003). Consequently, interactions at a distance require the establishment of explicit inter-site communication processes for description, representation, specification, and communication of task performance and outcomes (Ciborra & Patriotta, 1996; Hinds & Bailey, 2003). These processes need to be supported by explicit use of mediating communication technologies such as e-mails, phone calls, electronic file transfers, videoconferencing, and various computer-supported collaborative work technologies.

From the perspective of the researcher/observer, breakdowns caused by distance, with consequent explicit requirements for process and technology support for inter-task communication and adjustment, make the previously obscure, implicit, subtle interaction processes now open, explicit, and an observable subject of investigation. This in turn reveals fine-grained differences in interdependencies that were previously obscured by relatively obvious, salient, coarse-grained, task-division-based differences.[4]

Shift to information and knowledge work. A second reason for re-examining task interdependencies is an increasing shift to services, and information and knowledge work (Grant, 1996; Stinchcombe, 1990; Zollo & Winter, 2002). Unlike concrete manufacturing work, knowledge-based services and knowledge work can be easily digitized and shipped across global distances. Thus globalization, technology, and the move to knowledge and services work mutually reinforce one another (e.g., Bryant, Vertinsky, & Smart, 2007; Malhotra, Majchrzak, Carman, & Lott, 2001).

On the other hand, traditional concepts of task interdependence were developed in the context of relatively concrete and routine factory work or simple office work, where the flow of the work object (movement of the product being manufactured or the paper file being transferred[5]) was concrete and therefore observable by all. This made it easier for workers to observe and come to a common understanding of the state of the work object and its transformation (manufacturing) process (e.g., Bechky, 2003; Engeström, Engeström, & Kärkkäinen, 1995). However, abstract, knowledge-based interactions and outcomes, that is, software development or R&D (Faraj & Sproull, 2000), are not so easily observable by workers and their managers (Bechky, 2003; Kiesler, Wholey, & Carley, 1994; Kraut & Streeter, 1995). The lack of observability of work and its outcomes introduces another challenge to coordinating work across various parties. The abstract nature of knowledge work distributed across global distances adds additional barriers to observability, and thus makes the process of joint understanding and sense-making regarding the work object even more problematic (Cramton, 2001; Nemiro, 2000).

Increasing product complexity. Third, traditional patterns of interdependence were developed in the context of relatively simple products and product lines. Recently, the development of complex, composite products (e.g., the new generation of Boeing 777 aircraft, or the International Space Station, or other complex products sharing a common platform such as Smart Car or mobile phones) involve artifacts composed of numerous hardware and software components, resulting in highly complex work breakdown structures. These projects extend interdependence across geographical, organizational, and product boundaries. On top of this, joint product development across numerous globally distributed subsidiaries and partner firms (e.g., the case of the Boeing 777 passenger aircraft, or the Joint Strike Fighter) adds an additional level of complexity to an already complex situation.

At present the guidelines for global distribution of work are primarily experience-driven, *ad hoc*, and without a cohesive theoretical base. This body of knowledge, commonly communicated through practitioner-oriented books, articles, and white papers, focuses on specific instances of management practices for GDW, without grounding them in generalizable organization theory and IB literature. As mentioned above, the classic theory of interdependence, and its associated communication and coordination requirements, has traditionally provided the underpinnings of work design practices in collocated, manufacturing contexts. With increasing globalization, it is important to have a robust definition and typology of interdependence that is appropriate for understanding and designing globally distributed, complex, and increasingly knowledge-intensive work.

RESEARCH OBJECTIVE AND APPROACH

This paper attempts to develop an extension to the classic typology of interdependence. It will do so by developing a robust typology that can help elucidate, analyze, and guide the design of globally distributed, complex, and increasingly knowledge-intensive work. We aim to examine the adequacy of the current state of theoretical knowledge about interdependence in designing offshored work, and develop a revised typology that can help with design guidelines appropriate for offshored work.[6]

We attempt to show that global work distribution, combined with the increasingly complex and knowledge-intensive nature of work, highlights patterns of interdependence that were not obvious in collocated work. By confronting the classic typology of interdependence of distributed work (both local and global) with commonly accessible scenarios derived from direct observation and business and academic literature, we examine whether current theory can explain the operational issues related to them. We show that the patterns of work in these scenarios cannot be fully understood by the classic typology of task interdependence proposed by Thompson (1967) and Van de Ven et al. (1976). We then introduce a set of concepts that take into account both the global distribution of work, and the increasingly complex, abstract, and knowledge-intensive nature of modern work. We then show how this revised theory of interdependence is better suited to the design of offshored work.

Our arguments are organized in three sections. First, we review the classic typology of interdependence (Thompson, 1967; Van de Ven et al., 1976). We then present scenarios of GDW that cannot be fully explained by the classic typology, thereby identifying the need for improvement. Third, based upon the concepts of *hand-offs, integration interdependence* (Biggiero & Sevi, 2005; Malone et al., 1999), and *stickiness* (von Hippel, 1994, 1998), we offer a revised typology of task interdependence to address the shortcomings. We then show how this revised typology can be used to develop guidelines for designing complex work in a globally distributed context, within which most MNEs operate nowadays. Finally we discuss implications for research and approaches to designing global work that have practical relevance to managerial offshoring decisions.

OFFSHORING AS A TRIGGER FOR REVISING THE CLASSIC TYPOLOGY OF TASK INTERDEPENDENCE

The Classic Typology of Task Interdependence

Thompson (1967) defined interdependence as the need for achieving concerted action. Van de Ven et al. (1976) further clarified this as the extent to which personnel in an organizational unit are dependent upon one another to perform their individual jobs. Recently, interdependence between two tasks has been defined as the extent to which the performance and outcome of one task are affected by, or need interaction with, the performance and outcome of the other task (Crowston, 1997, Purser & Montuori, 1995). Thus task interdependence between tasks performed at two GDW locations is the extent to which the performance and outcome of tasks performed at one location are affected by the performance and outcome of tasks performed at the other location. This classic typology of task interdependence distinguished three types of interdependence: pooled, sequential, and reciprocal, as illustrated in Figure 1.

Van de Ven et al. (1976) added a fourth type of interdependence – team or intense interdependence – to complete the classic typology of interdependence. Figure 1, adapted from Van de Ven et al. (1976), provides models of these interdependencies: rectangles represent work sites or locations, and circles the actors within the location. Since the classic typology does not distinguish

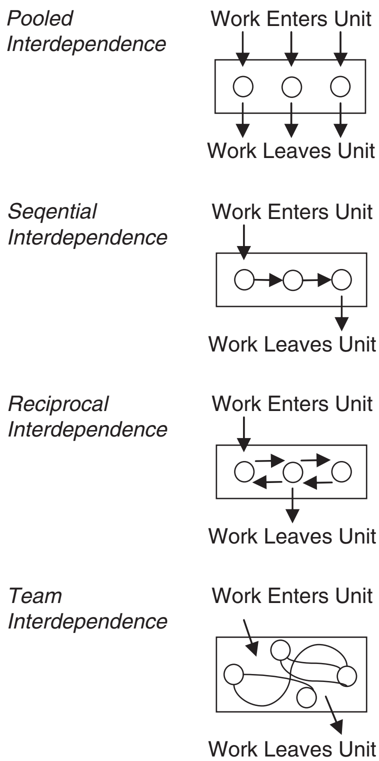

Figure 1 Classic taxonomy of task interdependencies (*Source*: Van de Ven, Delbecq, & Koenig, 1976). Rectangles indicate work units, and circles workers.

between collocated and distributed work, we show all actors in a work unit collocated at the same work site. It is also important to note that no theoretical work has been done in this area since the Van de Ven et al. (1976) article.

First, *pooled interdependence*[7] is defined as the situation in which "parts contribute *independently* to and are supported by a whole, and no workflows exist between actors" (Van de Ven et al., 1976). Individual efforts and contributions of each work unit are completely independent of other work units, and exist and operate by themselves, on their own. Thus, as shown in Figure 1 for pooled interdependence, the total production function is cleanly separable into discrete, completely independent, but similar sub-tasks performed by different actors. The only connection between sub-tasks is the periodic (e.g., annual or quarterly) linear addition or pooling of their outcomes at the system level. However, each actor or work unit[8] performs its task independently of each other, and need not be aware of other actors or be concerned about subsequent pooling. Periodically the actor's individual contributions are pooled at the company level, such as overall sales or productivity/performance. However, the outcomes of each work unit (each salesperson or manufacturing division) have existence and value independent of outcomes of other work units.

Second, with *sequential interdependence*, individual work unit activity is directly connected in a linear fashion (Van de Ven et al., 1976). Thus in Figure 1 work unit A's output (e.g., the frame of an automobile) becomes input to work unit B (for installing the interior). Each work unit adds value incrementally to the work in a serial manner.

Third, *reciprocal interdependence* refers to situations in which the outputs of one unit become inputs for the other unit and vice versa (Thompson, 1967), and work flows back and forth between the two work units over a period of time (Van de Ven et al., 1976). An example is volleying a ball back and forth in tennis, or the back and forth of offers and counter-offers in a trade negotiation process. Another example would be the passing of product specification from a customer to an OEM (original equipment manufacturer), who in turn passes the finished product back to the customer.

With pooled interdependence, multiple actors perform independent tasks on different and separate work objects. In the case of sequential and reciprocal interdependence, at any given point in time only one work unit has custody, control or responsibility for the work object. At the time of work transfer, work, and when control of the work object is handed off from one work unit to another, there is a noticeable temporal lapse. Thus each actor performs his or her work acts "solo", but at the instance of work transfer hands it off to the next actor, who in turn performs his solo work act. The key difference between sequential and reciprocal forms of interdependence is that while workflow in the former is unidirectional, it can go back and forth in the latter.[9]

Fourth, Van de Ven et al. (1976) introduced team interdependence[10] to the typology: "work is undertaken *jointly* by unit personnel who diagnose, problem-solve and collaborate in order to complete the work. In team work flow, *there is no measurable temporal lapse in the flow of work* between unit members, as there is in sequential and reciprocal cases; the work is acted upon *jointly and simultaneously* by unit personnel at the same point in time" (Van de Ven et al., 1976: 325; emphasis ours). Whereas with pooled interdependence the actors work simultaneously but independently, with intense interdependence they work simultaneously and also jointly. An example would be members of a group, together, carrying a heavy and large object such as a large piece of furniture such as a sofa. There are no distinguishable "solo" acts or hand-offs between actors (cf. Alchian & Demsetz, 1972); it is not as if each member can carry parts of a bulky sofa independently, or one member can carry the whole sofa 10 feet and then hand it off to another member to carry it further. Thus team interdependence is qualitatively very different from pooled interdependence. As compared with pooled interdependence, team interdependence requires much higher levels of continuous inter-actor awareness, communication, information processing, mutual knowledge, trust, and mutual adjustment.

Examining the Robustness of the Classic Typology

A construct is adequate only if it helps us understand and discriminate between significant variations in the phenomenon, and therefore its design consequences. We next examine the classic interdependence typology to determine whether it can fully explain the following three work scenarios[11] for offshoring and GDW, and their related organization designs in Table 1.

For each of the scenarios representing pooled, integration and sequential conditions (A, B and C in Table 1), in the right-hand column, we discuss how classic interdependence typology applies and which questions it is unable to answer. These unanswered questions then direct our attention to refining and extending the typology.

The underlying patterns of interdependence identified in these scenarios are not new; they existed in pre-global, collocated work. However, some of the differences between the scenarios identified in Table 1 were overshadowed or obscured by observations of the coarse-grained phenomenon of collocated concrete and simpler work tasks, and therefore were not as salient nor explicitly recognized and examined in the earlier studies. Consequently, the strategies and coordination mechanisms for dealing with these complexities have been relatively underdeveloped. It can also be argued that some of these patterns of interdependence may also be seen in collocated work. We agree; however, they become much more noticeable, explicit, and salient, and have stronger implications, when examined in the context of global work. Convergence of the three trends (global distribution of work, increased information and knowledge-intensive work, and increased complexity of products and services) have significantly intensified the time and effort required to manage these interdependencies, thereby making them even more salient. Using the analyses of Table 1, we next develop an extended typology of interdependence by identifying the requirements for an extended typology, followed by an introduction and integration of related theories and concepts that help us address our gaps in understanding.

Requirements for Revising the Classic Typology

Table 1 identifies a number of questions where the classic interdependence typology is unable to distinguish between work design and the coordination requirements of the cases at hand. These questions have important managerial implications for work partitioning, work design, and the design of communication, coordination, and control mechanisms. Next, we translate these questions into requirements for theory building.

Types of hand-off. A revised typology of task interdependence should explicitly recognize the existence of work hand-offs as a basis of interaction between actors during sequential and reciprocal interdependence. Moreover, it should be able to differentiate between cases that do not require extensive communication and clarification efforts during hand-offs (e.g., in the "throw-it-over-the-wall"[12] scenario – Case C1 about transferring television manufacturing requirements), and those that do (Case C2 about transferring banking information system requirements). In the case of television manufacturing requirements, owing to their concrete and relatively unambiguous nature, there is no or only minimal need for additional communication and information sharing across actors at the time of hand-off; the transfer of the well-laid-out and structured design document is sufficient. In this case the potential complexity, uncertainty, and ambiguity of the work object (the system design document) coupled with high levels of information and knowledge asymmetry among the actors, calls for extensive information exchanges between them at the time of hand-off, in order to clarify underspecified, ambiguous, and uncertain items. The revised typology should distinguish between cases requiring the minimal hand-off efforts on the one hand, and hand-offs requiring high levels of information and knowledge exchange activities on the other.

Table 1 Classic interdependence taxonomy applied to some modern work design scenarios

Scenarios and cases	*Questions raised by the cases using the classic interdependence taxonomy*
Scenarios A: Outcome pooling *(According to classic interdependence taxonomy: pooled interdependence)* *Case A1. Grape picking* Consider a boutique vineyard and winery in Sonoma County, California, with rows and rows of grapes to be picked by a crew. Each crew member works independently on his/her own, selecting and picking the grapes and putting them into the basket. At the end of the row, all baskets picked by the team members are dumped (pooled) into a single bin to be taken by tractor to a hand-sorting process. *Case A2. Medical research labs* Medical research labs in Thailand, Vietnam, PRC, Hong Kong, the EU, and the US work independently of each other in monitoring avian flu, and researching its potential sources. To the extent of monitoring and research of local outbreaks of avian flu these labs are relatively independent of each other. However, they keep each other regularly informed of their findings and results, and regularly exchange data and information. By pooling information from various countries, these labs can identify the beginning of the mutation of the virus or the start of a pandemic.	Both A1 and A2 are examples of pooling of outcomes. In the grape picking case (A1) the pooling is of physical output (grapes picked); in the medical labs case (A2) information about local outbreaks of a disease. However, the question is: How are cases A1 and A2 similar and different? In both cases actors perform their tasks relatively independently of each other. However, in the medical research labs case (A2) various actors are continuously aware of and keep each other informed of their ongoing outcomes: this would seem superfluous in case A1. How does classic interdependence taxonomy explain this difference?
Scenarios B: Activity integration *(According to classic interdependence taxonomy: no classification exists to distinguish this type of work arrangement)* *Case B1. Laptop computer parts* In response to a particular customer specification for a laptop computer, computer parts are shipped from various OEM suppliers in South Korea, Taiwan, China, and Indonesia to the Dell assembly plant in Malaysia. The pre-designed and manufactured parts are assembled easily, and the assembled laptop computer is shipped to the customer. *Case B2. Software components* Recently coded modules and software components of a software system are collected and shipped electronically from various software vendors and service providers to the TCS/Skandia Financial Concepts development facility in Bangalore, India. The software integration group is responsible for assembling and testing these software modules into a single integrated system. The process of integration involves several multi-site video-conferencing sessions between the multiple sites, many back-and-forth discussions, and frequent modifications to the various modules in order for them to be able to fit and work together. After numerous modifications, reviews, and integration tests, the software is available for deployment. *Case B3. Boeing 777 design* The design of the Boeing 777 is subdivided across a number of globally distributed teams, each team responsible for one aspect of the design, working in parallel (Sabbagh, 1996). For example, the airframe design team works on the design of the	How are interdependency scenarios B (integration) different from those in A (pooling)? In both cases (A and B), actors work independently on separate tasks in parallel. However, in case B the final outcome requires an additional activity to integrate the outcomes of each of the parallel work activities, whereas in case A, no such integration is needed within the work system. Moreover, in case A, all actors working in parallel perform the *same* task, independently of each other, and their outcomes have intrinsic value, independent of the outcomes of other actors. With the integration scenarios in B, on the other hand, the actors perform *different* tasks in parallel, also independently of each other; however, their outcomes hardly have value in themselves. The value in case B emerges only after the integration step. How does classic interdependence taxonomy explain the differences between A and B? How are the interdependencies in laptop computer parts (B1) and software components (B2) similar to and different from each other? Why does case B2 require extra effort for mutual adjustment at the time of integration, whereas case B1 requires minimal or no mutual adjustment? What are the similarities and differences between the software components case (B2) and the Boeing 777 Design case (B3)? In both cases they integrate complex, knowledge-intensive products. However, in case B2 mutual adjustment between various actors occurs only at the time of integration, whereas in case B3 it occurs regularly during the parallel work phase as well as at the time of integration. Again, how does the classic taxonomy of interdependence classify and describe the differences in work structures and processes between B1, B2, and B3?

Table 1 *Continued*

Scenarios and cases	*Questions raised by the cases using the classic interdependence taxonomy*
fuselage, wing, and tail-assembly structures, whereas the power plant team works on the design of the engines powering the aircraft. The individual component designs are done in parallel and then integrated into a unified design. While the problems of "fit" between various components are resolved during the integration phase, these problems are manageable thanks to the use of a CAD (computer-aided design) visualization tool during the parallel design phase. This tool visualizes various designs, its airframe and structures, its hydraulics, avionics, and wiring, and its power plant, as they proceed, on an electronic mock-up of the aircraft. Any potential conflicts, such as structural elements, hydraulics, or wiring occupying the same physical space, are easily identified on this visual mock-up and addressed by the design teams interacting with each other during the parallel design phase, thereby reducing the fit problems during the design integration phase.	
Scenarios C: Requirements transfer *(According to classic interdependence taxonomy: sequential interdependence)* *Compare the following two cases of software requirements transfer from the perspective of the persons specifying the requirements to the programmers.* *Case C1. Television requirements* Requirements for embedded software for television controls are transmitted electronically from the Philips Consumer Electronics Division R&D group in Eindhoven, The Netherlands to the Philips Software Division at the Philips Innovation Campus in Bangalore, India, with a request for delivery by a certain date. These requirements are for a physical product, and are precise, certain, unambiguous, and specified in a formal and precise language that is understood by electronic engineers on both sides. The software engineers in Bangalore commence work on requirements as soon as they receive them and deliver the needed code back to Eindhoven just before the due date. *Case C2. Banking requirements* Requirements for software for a financial information system are developed by domain analysts (banking experts) at a bank's HQ in Amsterdam and sent to the Financial Systems Division of Tata Consulting Services (TCS) in Bangalore. A team of business systems analysts is flown in from Bangalore to Amsterdam, which works closely with the bank's specialists in Amsterdam to understand the requirements as part of the transfer process. The TCS team then returns to Bangalore, where it holds a series of meetings with the software engineering team to explain the requirements to them. This requirements transfer process also includes frequent video-conferences between the bankers in The Netherlands and the business systems analysts and the software engineering team in India before programming can begin. Furthermore, during the programming phase there are frequent clarifications and requirements refinements and modifications, frequent teleconferences, and occasional flights between Amsterdam and Bangalore.	Both the television requirements case (C1) and the banking requirements case (C2) are in classic terms considered as "sequential task interdependencies", where work is being transferred from The Netherlands, the requirement specification site, to Bangalore, the programming site. However, as compared with the television requirements case (C1), where the transfer process is relatively effortless, the banking requirements case (C2) requires a considerable expenditure of time and resources for transferring work from The Netherlands to Bangalore. How can the classic taxonomy of interdependence explain the differences in the work structures and work processes in these two cases?

Interdependence during parallel task execution. The typology should clearly differentiate between "simultaneous parallel independent acts" as in pooled interdependence of the grape pickers in (A1), and "simultaneous joint acts" as in intense interdependence represented in the Boeing Design case (B3). In the cases on grape picking (A1), laptop computer parts (B1), and software components (B2) there is no mutual awareness or information sharing between various actors while the work is being done at dispersed sites. In the case of medical research labs (A2) and Boeing 777 Design (B3) there are considerable ongoing requirements for actors to be aware of each other's progress and status. This leads to the need for knowledge or information sharing through mutual signaling or observation. The revised typology of interdependence should thus recognize cases involving a need for information sharing for sustaining mutual awareness.

Integration of outcomes of parallel tasks. The revised typology should recognize the difference between cases in which the outcomes of simultaneous parallel work acts are produced and essentially remain independent of each other (pooled interdependence), and those cases in which the outcomes of simultaneous parallel acts will need to be "fitted" together through an integration work step (differences between scenarios A and B – see Table 1). In the former case (pooled interdependence) the distributed actors have no requirement of being aware of each other's work, or being concerned about the outcomes produced by other actors. Thus they are relatively independent of each other. In the latter scenario, seemingly independent parallel activities are actually highly interdependent, as actors in each sub-activity need to be mindful that the outcome of their activity will need to be integrated with the outcomes of other activities, involving a "fitting" activity. Therefore any changes or adjustments made in the production or design work outcomes of any of the parallel tasks can impact on its fitting together with the outcomes of other activities. For example, if the producer of an automobile part changes the machining tolerances, or a fastener, or substitutes a different material, his automobile part deliverable may not fit with the auto body, requiring additional work or rework at the time of assembly. Thus while each of the part producers may be able to work independently, they need to be keenly aware of the fact that their individual outcomes have to ultimately come together and be integrated. Moreover, the revised typology should be able to differentiate between simple fit (laptop computer parts, case B1) and fit requiring substantial mutual adjustment during the fitting process (cases involving software components in B2 and Boeing 777 design in B3).

In summary, the revised typology should be able to distinguish between the information processing requirements of different types of hand-off as well as different types of parallel work. Furthermore, it should also be able to differentiate between independent parallel work requiring only simple pooling of their outcomes, and the execution of parallel tasks requiring extensive fitting or integration activity both during and at the culmination of these parallel tasks. The following section introduces three concepts that will be used to revise the typology of interdependence such that it can distinguish between the scenarios identified in Table 1.

THREE CONCEPTS FOR REVISING THE TYPOLOGY OF TASK INTERDEPENDENCE

To further develop these extensions for their relevance to offshored work, we borrow three concepts from the current organization design and industrial engineering literature: integration interdependence, hand-offs, and stickiness.

Integration Interdependence

Although the idea of subdividing an artifact into its components, working on the components in parallel, and then assembling the components to obtain the finished product has been with us for a long time (March & Simon, 1958; Simon, 1950), its implications for interdependence and global work design have not been explored using extant theory on interdependence. As early as 1973, Galbraith pointed to the importance of integrating multiple streams of independently executed activities. However, he did not explore further the interdependence implication of integrating activities, and later work by Van de Ven et al. (1976) failed to include this work by Galbraith in their typology of interdependence.

More recently MIT's Center for Coordination Science has re-introduced the idea as "fit dependence", where "multiple activities collectively produce a single resource" (Malone et al., 1999). Building on Malone et al.'s (1999) work and based upon the requirements of the unresolved scenarios in Table 1, both in manufacturing and in services work (cf. cases on laptop computer parts, software components, and Boeing 777 design – cases B1, B2, and B3 above), we identify and define the concept of "integration interdependence" as an addition to the classic pooled, sequential, reciprocal, and intense typology described earlier. Integration interdependence is characterized by four aspects of the work case. First, the overall task is subdivided into sub-tasks that address various, different components of the work. Different actors working separately in parallel perform these sub-tasks of producing different components. The sub-tasks are typically different from each other, requiring different work processes, skills, and capabilities from their performing actors, and produce different components of the work outcome. For example, the sub-task of designing the aircraft's structure (its fuselage, tailplane, and wing structures) is typically very different from designing its power plants (and is often performed at different companies, often separated by global or continental distances). Second, the outcomes of the parallel task segments do not have much value in themselves; they acquire value as part of the integrated whole.[13] Third, the integration of parallel streams of activities requires a "fitting" or integration process. The fit activity is the value-creating activity: in contrast to pooled dependence, without this concluding process intermediate outputs do not have much value. Fourth, actors in each of the individual parallel activities need to be aware of the status of and changes in other work activities, to the extent that the performance, status, and outcome of the other activities can impact either on their own work, or on the timing and work required to fit their outcomes.

Here we should be careful in differentiating integration interdependence from pooled interdependence, which also involves parallel activities. However, the similarity is superficial. In pooled interdependence, parallel activities are independent of each other, are essentially similar in nature, and produce outcomes that are similar, and each parallel activity's outcome has independent value irrespective of the outcomes of other parallel tasks. Since pooling is a simple linear summation, no "fitting" activity is required, and actors performing parallel activities do not need to be aware of each other. In terms of Thompson's (1967) and Van de Ven et al.'s (1976) scale of interdependence intensity, we position integration between sequential and reciprocal interdependence (Figure 2, left-hand column).

Compared with sequential interdependence, actors face more complex interactions when partitioning and ultimately integrating the work. Compared with reciprocal interdependence, in integration interdependence actors have the chance to work more independently on their stream of activities. However, this placement of integration interdependence on a scale between sequential and reciprocal is, at best, speculative. More work is needed before we can precisely locate integration interdependence along an ordinal scale of interdependence intensity.

Work Hand-offs

Next we build upon Grandori's (1997) concept of transactional interdependence. Grandori (1997: 903) uses Williamson's (1981) transaction cost economics[14] to define transactional interdependence as:

> a transfer of goods or services through a technically separable interface from one stage or activity A to another stage or activity B … The taxonomy of transactional interdependence also includes the more complicated case in which the transfer of goods or services is two-way, i.e., each activity provides inputs to the other.

Transactional[15] interdependence thus includes both sequential and reciprocal interdependence, and is characterized by the interface across which goods and services are transferred between tasks.

The explicit recognition of the construct "technically separable interface" identified by both Williamson and Grandori is essential to understand fine-grained differences in interdependencies in GDW that is often abstract and complex. The interface is the point where control of the work object is actually transferred from the preceding activity A at one location to the succeeding activity B at another location. The point of work transfer itself may be minimal and instantaneous, or may have a finite duration and require explicit effort, but it exists nevertheless. It should also be noted that the work transfer at the point of the technically separable interface can include two items: the work object itself, and information about the status of the work object. The information about the status of the work object could either be implicit in the work object itself (i.e., by observing the work object one can understand its current state) or be in the form of a separate explicit communication, either accompanying the work object (e.g., a "packing slip") or transmitted separately. In either case information is needed to apprise the second party in the transaction about the status of work

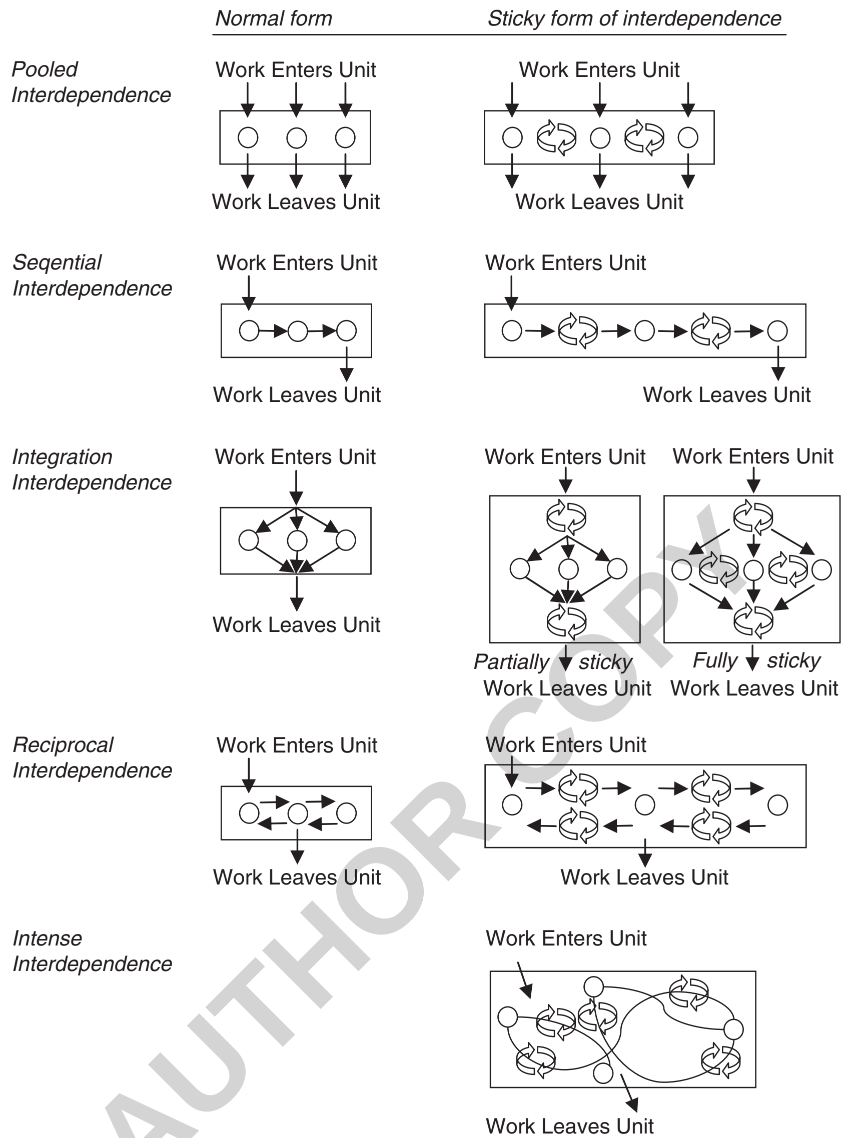

Figure 2 Task interdependencies: a revised categorization. Circular arrows represent the sticky nature of interdependencies.

already performed, and any special, non-standard work requirements for it.

Instead of the term "technically separable interface", we elect to use the metaphorical term "hand-offs" (as in a relay race) to express the idea of the interface "visually". Thus both forms of transactional interdependence, sequential and reciprocal, include explicit hand-offs between activities A and B. Furthermore, in the case of integration interdependence, hand-offs occur both at the time of partitioning overall work into sub-tasks (work segments are handed off to actors performing the parallel tasks), and at the time when the sub-tasks deliver their outcomes to the fitting or integrating activity (each parallel task hands off its deliverable to the integration task).

Stickiness

Earlier we noted extensions to interdependence typology need to recognize and distinguish between variations in the costs of work transfer and information and knowledge-sharing between tasks. These costs can arise both in transactional hand-offs (requirement 1) and information transfer for mutual awareness between parallel tasks (requirement 2). The concept of "stickiness"

(Szulanski, 1996, 2003; von Hippel, 1994, 1998) explicitly addresses these costs of information transfer. Von Hippel (1994) defines stickiness as:

> the incremental expenditure required to transfer that unit of information to a specified locus in a form usable by a given information seeker. When this cost is low, information stickiness is low; when it is high, stickiness is high.

Von Hippel's definition of stickiness of information transfer depends upon the characteristics of the sender, the receiver, the organizational context of information transfer, and the information itself. The characteristics of the information include its size, tacitness, ambiguity, and public or private nature (von Hippel, 1994). When the information is tacit, it is difficult to express or codify for a variety of reasons, such as ambiguity, equivocation, uncertainty, and complexity. Thus stickiness is likely to be high for large volumes of tacit, ambiguous, equivocal, uncertain, and complex tasks. It requires higher levels of effort in transferring information across two sites, or in developing mutual awareness of parallel work sites. Moreover, with global distribution, the difference or gap between sender and receiver characteristics is even higher, thereby increasing stickiness, which would therefore need extra effort to transfer information. Thus in the global distribution of work, stickiness between and across tasks is a critical aspect of the extension to the typology of interdependence.

It should be noted that the classic typology considered task interdependence separately from task uncertainty (Van de Ven et al., 1976). Both factors influence information processing demands in their own right (Galbraith, 1973). Von Hippel's (1994) construct of stickiness provides a way of integrating the two concepts. Thus, in reclassifying interdependence we introduce the idea of "non-sticky" vs "sticky" interdependence. *Non-sticky interdependence* is characterized by relatively unambiguous, certain, unequivocal, simpler tasks, and therefore has a minimal and instantaneous hand-off. Both sticky hand-offs and explicit signaling and observation for mutual awareness, on the other hand, characterize *sticky interdependence*. Both cases require a finite level of effort for information processing across tasks.

Next, with interdependencies arising from work transfer, we extend the Von Hippel definition of stickiness to include stickiness of transferring physical as well as information products; it would also include incremental costs of transfer of both. Moreover, when work transfer across global distances results in additional risks, such as a potential loss of intellectual or physical property due to natural or political circumstances, these risks in turn can increase the incremental costs of the potential risk and further increase the stickiness of work transfer. Compared with GDW, the cost of transfer of physical products for collocated work is relatively minimal and therefore often not explicitly recognized. In global supply chains of physical products, depending upon the distance between and the contexts in the countries of origin and destination, stickiness and the cost of transferring physical work can be significant. Although the concept of stickiness can be applied to physical work transfer, we are focusing primarily on the impact of information stickiness on interdependence.

Finally, based upon our extensive and close-up observations of and work with companies in the field, we can further extend Von Hippel's definition of stickiness by recognizing that stickiness between two sites is a dynamic concept, and keeps changing as a function of the past history of interactions between the actors, the changing perceptions of the actors, the creation and acceptance of standards for transfer, de-regulation and re-regulation of trans-border information and product flows, and most importantly with innovations in bridging technologies for moving bits (telephones, e-mail, VoIP, video-conferencing, CSCW and group technologies) and moving products and people (airplanes, airline routes, highway systems and cars). While these are important extensions to the idea of stickiness, we leave the discussion of the implications of these extensions to a future, more practitioner-oriented paper. Next, we examine the implications of integration interdependence, hand-offs, and stickiness for task interdependence in offshored work.

Toward A Revised Typology of Interdependence for Offshored Work

Figure 2 presents a revised typology of interdependence that accounts for the three concepts – hand-offs, stickiness, and integration – identified in the above section. It illustrates our distinction between normal (non-sticky) forms and sticky forms of task interdependence using circular arrows to represent stickiness. Figure 2 also includes integration interdependence as an extension to the typology proposed by Van de Ven et al. (1976). As was the case in Figure 1, the models in Figure 2 also represent work cases where the actors are collocated.

Non-sticky dependencies in Figure 2 refer to cases where the information and work transfer expenditure between tasks is close to zero. Additional or supporting information does not have to be transferred, because either the transfer is not needed (as in the case of pooled interdependence), activities are certain and standardized, or actors can transfer information highly efficiently (for instance, they work in the same space and can simply watch or listen to a colleague). Similarly, the physical product can be transported at minimal cost or risk. Thus with pooled, non-sticky task interdependence actors can proceed without paying much attention to their counterparts. With sequential interdependence they can "throw their outputs over the wall" as long as these meet pre-specified criteria. We call this a "clean hand-off" (Kumar et al., 2005), where "clean" denotes an instantaneous transfer of work without any, or only minimal, communication at the time of hand-off.

Non-sticky integration interdependence occurs when actors partition work routinely, and they standardize the outcomes of each activity stream. Thus the integration activity, as in the case on laptop computer parts (B1), is a routine activity without much information processing requirement. Non-sticky reciprocal interdependence, though more intense, exists when highly experienced actors execute standardized, back-and-forth activities for which minimal adjustment is required. An example is customer–waiter interactions when the customer is already accustomed to the food options and ordering procedures at a fast food restaurant chain[16] (Bradach, 1998; Leidner, 1993). Work is easily passed around in a back-and-forth manner. We believe that intense interdependence, by definition, concerns only sticky information requiring intense interaction. Since actors work simultaneously, work changes constantly, and generates information of which actors must be continuously aware.

Sticky task interdependencies (right-hand column in Figure 2) appear when the work is novel, ambiguous, uncertain, equivocal, and complex. Sticky pooled interdependence refers to cases where, even though tasks are performed independently, actors must continuously be aware of their counterparts' activities to proceed on their own work. For instance, in aerobatic flight teams such as the Blue Angels, Thunderbirds, or Red Arrows, each pilot has an individual, tightly scripted role as part of a group flight plan (Thunderbirds, 1996). Still, pilots monitor each other closely and continuously in flight to sustain case awareness because any deviation – even a minor one – must immediately be acted upon (see circular arrows in the sticky pooled interdependence part of Figure 2, representing the sticky nature of interdependencies). While the performance of tasks does not require any mutual awareness, its coordination may. The script does not eliminate information-sharing and communication needs during the actual performance of tasks. Stickiness results from the combination of extremely close interdependence, high speed and risk, and the unique nature of each situated performance, even though its ostensive dimension ("official version") is tightly scripted, structured, and governed (Feldman & Pentland, 2003; Pentland & Rueter, 1994). With sticky sequential, integration, and reciprocal interdependence, work hand-offs require intense communication, information-sharing, and work transfer activities. In a hospital, a night shift nurse may not fully understand the notes made by the daytime shift (sequential sticky interdependence). At the time of hand-off, nurses from both shifts have to interact to clarify the evolving case of patients for whom they have responsibility. The stickier the information, the higher the level of communication required for awareness, understanding, and coordination with counterparts. With complex, uncertain, and ambiguous tasks, hand-offs in the case of integration interdependence can be sticky, both at the time of work partitioning and integration (left hand – partially sticky integration, Figure 2), and also during task execution (right hand – fully sticky integration, Figure 2). Hand-offs with reciprocal interdependence, as in the back-and-forth passing of paper drafts between co-authors (as in the case of developing this paper, distributed across three sites – Hong Kong, The Netherlands, and USA), may also be sticky if the co-authors need to explain their revisions and extensions to each other. Finally, intense (team) interdependence is always sticky, and is shown in the Sticky column.

The three concepts of integration interdependence, hand-offs, and non-sticky vs sticky interdependence complete our revised typology of interdependence presented in Figure 2. Whereas integration interdependence satisfies requirement 3, hand-offs and stickiness address requirements 1 and 2. Moreover, when we clarified the concept of intense interdependence to require both joint and simultaneous work (as compared with parallel but separate work), we addressed the requirement of differentiating between parallel pooled work and intense work.

INTRODUCING OFFSHORING AND GLOBALIZATION: INTERDEPENDENCE IN A GDW CONTEXT

In an era of increased globalization, few products and services are produced solely at one location. Organizations from around the world contribute work, expertise, services, and components to the production of goods and services. Hence work partitioning and interdependencies of collocated work need to be re-examined in the context of offshoring and global distribution of actors and loci of work. In Figure 3 we use the interdependence models developed in Figure 2 to illustrate interdependence models of GDW, common to most MNEs. As with the previous models, rectangles show work locations, and circles the work actors. Whereas in Figure 2 all actors were at the same location, in Figure 3 actors are now located at distributed work sites, one actor to each site.[17]

Work distribution creates two related work transfers across work locations: transportation of the work object, and transmittal of information about the state of the work object. First, the object of the work or its components needs to be transported across global distances. With a physical product, such as a disk drive, television, or a paper document, this requires physical distribution by trucks, rail, ships, or airplanes. Similarly, with services to be performed on a physical object, such as repairs of a laptop computer, the work object, that is, computer, may also need to be physically transported across these distances. The process of transportation creates additional work, costs, possible delays, and transaction interdependencies. Depending upon the nature of the work object, and the origin and destination of the transfer, physical transportation itself may be sticky. For example, with transportation of dual-use technology goods such as computer parts or centrifuges, or agricultural goods such as vegetables or poultry, the country of origin and destination often imposes regulatory approval procedures, security inspections, and tariffs that add to the stickiness (time and costs) of the transfer. The USA Patriot Act has now added another layer of stickiness, since all items must be posted to the masthead 24 h in advance of departure to ensure compliance with security requirements.

With an abstract (non-physical, information or knowledge) work object, such as an insurance claim, a marketing campaign design, a radiological report, or a requirements specification, the product, if non-sticky, can be digitized and instantaneously transmitted across telecommunication wires or satellite connections. However, when the information product is sticky, its transfer requires additional time and effort. When the information product is tacit, ambiguous, and not fully codifiable, the sending actor, to the extent possible, first codifies the information. Following the transmittal of codified information, both sending and receiving actors need to interact frequently and intensely to achieve a common understanding of work requirements (Bechky, 2003; Boland, 1991, Carlile, 2004; Ngwenyama & Lee, 1997; Vlaar, van Fenema, & Tiwari, 2008). For example, after making revisions to this manuscript one co-author transmits it across the Internet from Hong Kong to Rotterdam. The transmittal of a version is accompanied by intense interactive sessions to clarify the revisions as well as the intent of the revisions. The actors coordinate synchronously through tele- or video-conferencing, or Skype, to discuss revisions and clarify the remaining work requirements to complete the sticky transfer.

Second, information about the state of the work object, procedures already performed, and its status also needs to be transferred across global sites. With physical products or services, the product, parts, or forms being transported may carry with them some status information as visible attributes. In addition, any non-standard information about the product, or the requirements for non-standard or complex services, still need to be transmitted to the other side to enable the receiving party to continue processing the product. For abstract and complex products such as a computer program, plan, or design decisions, accompanying information may be needed to hand the product over fully to the offshore party. To the extent this information is sticky, time and effort needed to un-stick it needs to be considered in transferring work.

In summary, global distribution of work (such as in offshoring) and the resulting gaps or distances between actors and loci of work increase stickiness in four ways. First, given the geographic and time gaps between work locations, it is no longer possible for one actor to observe task performance by other actors directly, as in collocated work. Information about the work object that was available by mere observation is no longer available, and

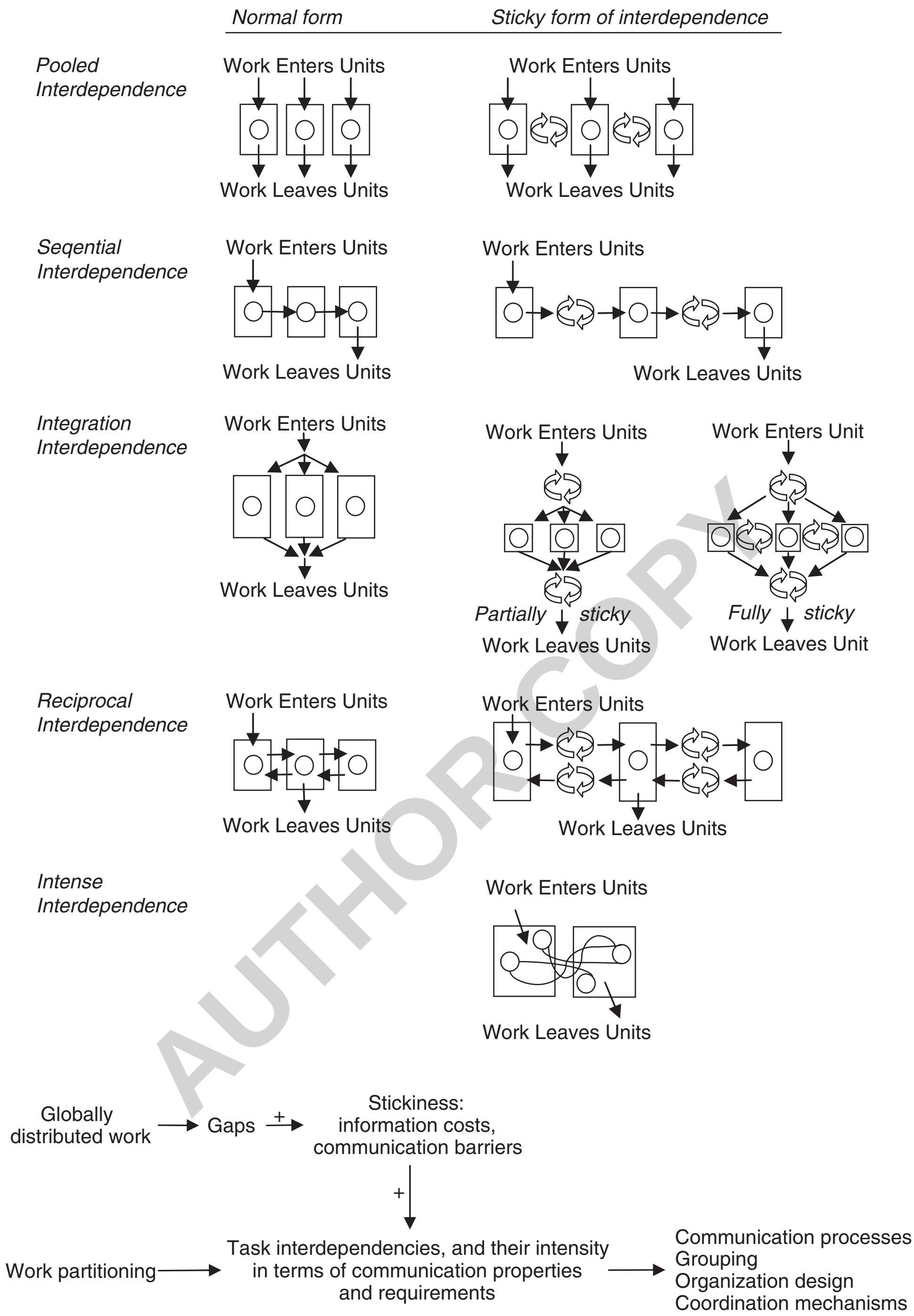

Figure 3 Distributed work environments and task interdependencies.

has to be explicitly collected, organized, and communicated. Second, issues that could have been unobtrusively resolved internally through subtle interactions and mutual adjustments at collocated work locations can no now longer be resolved, except through explicit long-distance communication (Herbsleb & Mockus, 2003; Teagarden et al., 1995). Third, global distances, in addition to obvious time and geographic gaps, often include culture gaps between the actors (Kumar et al., 2005; Von Glinow et al., 2005). These gaps impede joint sense-making and make it difficult for actors to arrive at common understanding of the work object, thus requiring further costs and time for transfer and sharing. Finally, as globally distributed actors exist and operate in different contexts, they are often not fully aware of each other's contextual constraints and opportunities. Intense, often reciprocal (back and forth) communication is needed between the various actors to overcome these problems in information transfer. On the other hand, research suggests that remote communication requires deliberate effort compared with the case of collocated workers (Allen, 1984; Cramton, 2001; Kraut & Galegher, 1990). Stickiness, by requiring distributed work sites to interact with each other, increases the intensity of interaction between actors.

GUIDELINES FOR DESIGNING OFFSHORED OR GDW

In the above discussion we explained how various global gaps (geographical, temporal, infrastructure, cultural, governance, and regulatory gaps) and the polycontextuality inherent in the case of offshored or GDW increase the complexity and information-sharing requirements of hand-offs and work integration across global distances. In this section we use the revised taxonomy of interdependence to develop guidelines for designing GDW. In comparing Figures 2 and 3, it is clear that distributing non-sticky work (comparing the left-hand columns of Figures 2 and 3) over global distances is simpler than distributing sticky work (right-hand columns of Figures 2 and 3). In non-sticky interdependence, as work moves from collocated to globally distributed, relatively straightforward transportation[18] and simple information transmission (transportation or telecommunication) processes are adequate for coordinating distributed work. With sticky interdependence, however, the existence of stickiness, either at the point of hand-offs or between parallel tasks, requires intense interaction and information sharing between actors performing these tasks.

Furthermore, global distribution, by increasing the gaps between the work sites and actors, also increases the stickiness of work. In collocated work actors are able to manage some stickiness of information by observing other actors and the work object (Bechky, 2003, Engeström et al., 1995); any remaining ambiguities or uncertainties could be reduced by subtle, spontaneous, and interactive communication between actors. However, when actors and tasks are distributed across global distances, conscious effort needs to be made to transfer the work object and to explicitly codify, transmit, and share sticky information through communication media. The difference between non-sticky and sticky interdependence is thus critical to understanding the implications of offshoring and distributing work across global distances.

Thus an assessment of stickiness and interdependence between tasks is the starting point for designing guidelines for the partitioning, design, and coordination of offshored GDW. Three guidelines may be followed for managing the levels of stickiness in an offshored or GDW context:

(1) avoiding or minimizing sticky partitioning and hand-offs;
(2) investment in reducing stickiness; and
(3) investment in managing and enabling residual sticky information sharing.

First, when stickiness is very high, it is reasonable to assume that the MNE will minimize its effect by keeping all or most of the work collocated. If, on the other hand, certain exigencies, such as the availability of expertise or resources, lower costs, or regulatory or political requirements, create the need for work distribution, the organization would be well advised to partition work into segments that are internally highly sticky, but are minimally sticky in relationship to other work segments. In software engineering terms this involves a work design strategy that maximizes the internal cohesiveness of the partitioned work segments (i.e., program modules) while minimizing their inter-segment coupling (Yourdon & Constantine, 1979). Depending upon the precedence relationships between these work segments they could then be arranged in a pooled, sequential, parallel, integration, or reciprocal work pattern.

However, this arrangement may still leave residual stickiness across parallel work segments and across sequential or reciprocal work hand-offs. To manage this residual stickiness we rely on the second strategy of investing in reducing stickiness. Especially in cases where GDW is likely to be repeated for a large number of cases, organizations may invest in "unsticking" some of the information (von Hippel, 1994). This can be done by reducing the equivocality and ambiguity of tasks and information through the use of mutually agreed-upon standards. An example of this strategy is investment in defining and using electronic data interchange (EDI) and product standards between organizations. Another method of reducing stickiness across distributed work sites and actors would be to provide training for cross-site, cross-organization, and cross-cultural awareness. By reducing the contextual or organizational gaps between locations, the stickiness of information transfer is reduced. An example of this strategy is the cross-cultural training for staff *and* clients implemented in the Netherlands by Tata Consultancy Services, a global IT services company. A final option for reducing stickiness is to reduce inter-context differences between sites by virtually immersing one site in the other site's context. An example of this guideline is the use by various Indian BPO companies of continuous and intense television feeds from US networks into the BPO call centers in India, thereby totally immersing the Indian call center personnel in the US's day-to-day happenings.

A third guideline, enabling the management of stickiness, relies on the use of bridging technologies (Kumar et al., 2005). These technologies bridge the gap across globally distributed locations either by moving bits (telecommunications) or by moving people (aircraft). One example is the use of a mediating computer representation that provides common access to the state of the work object by all actors at distributed locations. This strategy is especially useful in the case of parallel partitioning and distribution of work. Ideally, work should be partitioned such that there is no need for mutual awareness across distributed work sites, and parallel work at these sites can continue independently. However, in abstract and complex work often the nature of interaction between parallel work streams is such that achieving complete independence is not possible. Here stickiness exists across parallel work streams that must be resolved through mediating artifacts. An example of this was the globally distributed design of the Boeing 777 aircraft (Sabbagh, 1996). Design work was partitioned into functional design requirements such that the airframe team, the hydraulics design team, the avionics team, the power-plant team etc. were distributed across the globe. However, often the design decisions of one team interfered with the decisions of other teams (Sabbagh, 1996). For instance, during the design of the hydraulics it was found that the physical location of the designed hydraulics parts was intersecting and interfering with structural elements of the airframe. To avoid such interferences, the Boeing design team constructed a shared visual computer model of the aircraft design on which each parallel team could superimpose and locate its design. This model was available to all GDW teams through telecommunication links. Thus each team was aware of the ongoing design decisions of other teams and could mutually adjust its work in a continuous manner.

Another strategy for managing or enabling intense stickiness is to provide actors with computer-based collaborative work tools that support high-bandwidth real-time communication between distributed actors through technologies such as teleconferencing, video-conferencing, multi-site video walls, real-time distributed group support systems and desktop sharing. By simulating collocation, they provide the actors with tools for interacting intensely, sharing both codified and tacit information, as well as reacting and making adjustments when necessary (Kumar et al., 2005).

Finally, in some cases stickiness is so high that nothing less than a physical face-to-face meeting will do for co-creating joint understanding and shared meaning between the distributed actors. Here the actors occasionally need to travel physically across global distances to meet for knowledge-sharing and transfer. This strategy also has an added advantage: if executed successfully, it leads to a lessening of the gap between distributed actors, thereby laying the groundwork for reduced stickiness in the future.

APPLICATION OF THE REVISED TAXONOMY IN SUPPORTING OFFSHORING AND GLOBAL DISTRIBUTION DECISIONS

In the previous section, based upon the revised taxonomy of interdependence, we developed a set of guidelines for operationalizing GDW. In this section, using examples and mini-cases, we show how the taxonomy and these guidelines can be used for two typical tactical offshoring and offshore outsourcing decisions: the decision to offshore complex sticky tasks; and the decision about the choice of offshoring destination. The purpose of this analysis is to illustrate the usefulness of the taxonomy in understanding such decisions, not to provide a comprehensive list of offshoring issues and solutions. The guidelines and the taxonomy can be applied and further tested against a broader set of offshoring and global work distribution issues and situations in future, in-depth research.

Decision to Offshore Complex Sticky Tasks

Complex sticky tasks, such as R&D and complex administrative tasks, are characterized by high degrees of complexity, uncertainty, and ambiguity. Moreover, they may also involve large amounts of data. Thus by their very nature these tasks are highly sticky. During recent years, following on the relative success of offshoring standardized operational work, firms have begun to experiment with offshoring these more complex and ambitious tasks (e.g., knowledge process outsourcing). The availability of highly educated and relatively inexpensive manpower in emerging economies such as India and China makes a compelling economic argument for either offshoring the complete task, or distributing appropriate segments of these tasks to offshore sites. Examples of these situations are the GE (General Electric) offshoring of their engineering R&D to their Indian subsidiary, GPI (Gold Peak Industries, Hong Kong) offshoring part of their speaker division R&D to the United Kingdom and China, Barclays PLC and GE Capital offshoring their financial research to India, and Ferrari's offshoring of the design of their CAD/CAM system and parts of their automobile design work to Tata Consultancy Services (TCS) in Bangalore and Pune. Other examples include General Motors (GM)'s recent (29 October 29 2007) announcement launching an offshore research center on alternative fuel vehicles in China, and SAP Software AG's distribution of their product R&D over sites in Germany, Palo Alto, Bangalore, Shanghai, and Australia.

Given the high levels of overall stickiness (the high cost of work transfer and information sharing) between GDW sites, the starting point of the management decision to offshore R&D tasks is to assess the overall stickiness of the R&D task and to identify potential work-breakdowns structures that minimize inter-task, inter-site stickiness. Ideally the complete task, such as the design of GM's alternative fuel vehicles, is kept encapsulated and intact, and thus can be moved completely, "lock stock and barrel", to the offshore site (a particular example of replication strategy; Winter & Szulanski, 2001). In this case, sticky pooled parallel interdependence exists between GM's different, globally distributed R&D sites. Only minimal interaction and communication are needed between the sites. These distributed R&D sites work relatively independently of each other, and need be aware of each other only to be able to capitalize on any specific innovations achieved at other sites. For example, in the case of GM, it would be useful if the Chinese alternative fuel design team was aware of and could benefit from the design of low-friction bearings developed at, say, the Detroit fossil-fuel vehicle design site. However, without this awareness, the GM's Chinese site can still work independently of its Detroit site.

The second option is to subdivide the work into work segments that can be developed relatively independently of each other (horizontal work division), with the expectation that upon completion of the sub-tasks the outcomes of these tasks can be fitted together in an integrated package (sticky integration independence). An example of such work division and distribution is SAP's division of R&D work between its work sites in Germany, India, China, the USA, and Australia. The SAP ERP package is subdivided into relatively self-contained modules, and the development and maintenance of each module are allocated to a specific work site. These distributed sites work in parallel, relatively independently of each other. However, each module may access data from databases created and maintained by other modules. For example, the manufacturing planning module may need to use data from the inbound logistics and procurement (ILP) module. Thus changes in the ILP module may affect the work of the manufacturing planning module. Design and process standards are devised and enforced to ensure "fit" at the time of integration. However, despite these standards, system integration tests and adjustments are still necessary to ensure that in practice the separately developed modules do actually fit and work together.[19]

German car makers' (Mercedes Benz) US-based design center and GPI's electronics and speaker division (GPE) provide yet another example of division and distribution of R&D work. GPE has, in theory, divided its work along the R&D process chain. The front-end product creation and conceptualization phase is allocated to its UK-based KEF division, the product justification and approval to headquarters in Hong Kong, detailed design and manufacturing design distributed to its divisions in Shenzhen and Huizhou, China, and final product launch approval rests with the Hong Kong headquarters (vertical work division). In theory, again, the process charts for the R&D process also identify the points of work hand-off and responsibility transfer between the work sites. This work division results in a combination of sequential and reciprocal interdependencies between tasks and work sites. However, our recent investigations in the distributed R&D process show that, in practice, in this formal work division the hand-offs between work sites are not as clean as depicted on the process diagrams. At the point of the hand-off, and well into the subsequent phases, high amounts of interaction are needed for clarifications, feedback, and discussions between sites. This is a consequence of a high level of stickiness in work transfer at the hand-off. GPE manages this stickiness through employing bridging technologies such as regular inter-site video-conferencing, and approximately once a month face-to-face meetings between various sites.

Finally, more complex work divisions, such as a combination of horizontal and vertical work division, may be employed in globally distributing complex R&D and administrative work. This addition, together with its inherent stickiness, can create the requirements for even more complex and responsive communication and coordination mechanisms.

Decision: Choice of Geographical Location

In addition to the nature of work and information being shared across sites, stickiness also depends on the differences between the actors or parties transferring and sharing work and information. As discussed above, these differences include geographical, time, cultural (including language), infrastructure, regulatory, and governance gaps. At the very basic level the culture gap manifests itself as a language gap, which, for complex, highly sticky work, from a Western (US, UK, and Western European) perspective, gives Indian work sites an advantage over China. On the other hand, it has been suggested that China, because of its cultural proximity, may have advantage in dealing with Taiwan, Hong Kong, South Korea, and Japan. At another level, the culture gap also manifests itself as differences in economic and management practices, such as respect for private property and intellectual property, transparency, rule of law, and existence of and trust in institutions, such as stock markets, courts, and banks and court systems. Here again, in the case of complex intellectual work, from the perspective of US and Western European countries, Anglo-Saxon countries such as Canada, Ireland, and Australia may have an edge, followed by India. However, in the case of simpler and concrete work such as that performed by an OEM, the simpler and specifiable nature of the work reduces stickiness to the point where the differences between the actors are not as important. It is the combination of the lower stickiness of factory work with better infrastructure (i.e., low infrastructure gaps) that makes China a preferred destination for manufacturing.

However, as we discuss in the next two paragraphs, such broad generalizations, while popular in the business press, are rather dangerous, especially when the dynamics and totality of stickiness are taken into account in analyzing work location decisions. First, some of these differences or gaps, such as cultural, infrastructure, and regulatory gaps, are dynamic and continuously changing with experience, learning, new standards, and regulatory and infrastructure changes. As managers develop experience in working at global distances, especially working with partners, the level of mutual understanding increases, thereby reducing the level of inter-site differences and gaps. Furthermore, the introduction of new bridging technologies (such as Cisco's experimental Telepresence Technology currently being deployed by SAP, or Internet2 Cyberstructure Technologies such as the Access Grid and SAGE being deployed in e-science experiments) is constantly ameliorating the effects of geographical and time differences. However, in the immediate future these differences will remain, and will need to be considered in the choice of locating distributed work sites.

Second, we need to reiterate that stickiness between tasks and work sites is a function not only of inter-site cultural differences, but also of the nature of the work being distributed, various other gaps between the sites, and mechanisms such as technologies, standards, protocols, relationships, and organizational designs deployed to reduce or manage stickiness. Moreover, the decision to distribute and locate an offshored task also depends on the differences in production costs at various sites, as well as a variety of social, political, and regulatory contingencies. Furthermore, all of the above decision factors are continuously evolving and changing. Thus generalizing statements often found in the popular press, such as "China is good for offshoring manufacturing whereas India is good for offshoring IT Services and IT enabled services", need to be examined much more carefully in terms of the prevailing set of contingencies that may weigh one or the other factor at the time of the decision. Our paper intends to contribute to the quality of this complex decision process.

SUMMARY AND CONTRIBUTIONS TO RESEARCH AND PRACTICE

The underlying motivation of this paper was to examine the current theories of work design to see whether they can provide guidance for addressing operational level and work design issues in offshoring and global distribution of work. As offshoring and work distribution require that work be partitioned and distributed across globally distributed locations, our focus was to investigate whether the current theoretical conceptualization of a key work design concept, inter-task interdependence, was adequate in designing the operational aspects of work distribution. We investigated this by first examining the adequacy of the classic typology of interdependence in explaining patterns of work organization emerging in the context of globally distributed, information- and knowledge-intensive, highly complex work. We subsequently established that the classic typology, while adequate for explaining traditional work patterns for collocated, simple, physical production work, could not explain work patterns requiring intense interactions between actors and work sites in both transactional (sequential and reciprocal) and parallel work in the globally distributed, knowledge-intensive work environments common in offshoring. To address these shortcomings we introduced three concepts – integration interdependence, hand-offs, and stickiness – to develop an extended typology of interdependence. This extended typology was then used to model the consequences of transitioning from collocated to globally distributed offshored work. Using this model of distributed work we identified stickiness, both in work hand-offs and in parallel work, as a key concept differentiating interdependencies in offshored and GDW. Next, we proposed a set of guidelines for avoiding, reducing, and enabling sticky interdependencies. Finally, we used these guidelines in analyzing two typical offshoring decisions, namely the decision to offshore R&D, and the decision about the offshoring destination. Our analysis shows that this finer-grained revised typology of interdependence, by providing a better understanding of offshoring decisions, provides important contributions to both research and practice in IB studies.

First, in terms of theoretical contributions, we have shown how an emerging IB phenomenon – the offshoring or global distribution of work – has created the need to revisit and revise established organization typology and design concepts. The classic typology of task interdependence (Thompson, 1967; Van de Ven et al., 1976) has been used by a variety of researchers to understand or prescribe collocated organization design patterns. However, when exposed to the requirements for designing complex, knowledge-intensive, GDW, such as the typical offshored work, the typology was found wanting. By extending the typology of interdependence to accommodate the finer-grained requirements for these emerging patterns of global work, we have opened the door to important structural and design work that has been sorely missing in the organizational design, technology management and IB literature. It is surprising that no research on interdependence takes into account the physical location of work and its actors, given today's globalized world. This revised typology can also stimulate researchers puzzled over, for example, strategic-level or behavioral research questions on the management of virtual teams. Furthermore, the concept of GDW has been introduced previously, but it has not yet had wide reach (Kumar et al., 2005). With this revised typology, we expect future studies will examine GDW not only from a design perspective, but also from other disciplines.

Second, from a practical perspective it is our expectation that this revision to the interdependence typology will lead to the design of new innovative work design options and associated organization forms that will help reduce, enable, or manage stickiness in offshoring and global work. After all, the sobering realities depicted in the 2006 Duke/Booz Allen ORN Survey mandate that we take a critical look at how we organize work in general, but offshore in particular, so that managers do not lose "managerial controls" or "operational efficiencies" because their organizations do not have the knowledge, skills, and processes for coping with the challenges of distributing work globally (Couto et al., 2006). This requires further work in understanding the nature of work transfer stickiness and its relationship to physical and information stickiness. Here we have focused primarily on work hand-offs and information stickiness as key determinants of interdependencies in global work. A variety of global gaps, such as cultural, governance, regulatory and infrastructure gaps increase the stickiness of physical work transfer. A typology of work distribution that combines both information stickiness and physical stickiness (as in physically moving the work object in the case of offshoring manufactured work) will pave the way toward understanding and fixing design dilemmas typically observed in offshored and GDW.

At this point we also recognize that the objective of this research was to assess the usefulness of classic interdependence theory in the context of GDW, and to develop extensions to it in order to accommodate issues raised by global distribution of work. We did so following the theory construction methodology suggested by Weick (1989). This process was based upon the use of qualitative and secondary data such as published reports, interviews, and personal observations, and by conducting thought experiments. Further confirmation of the developed theory by using fieldwork including both quantitative and qualitative data will strengthen the theory. Second, the focus of this theory construction exercise was on understanding inter-task interdependence between distributed sites. In previous research, interdependence has been found to be a key determinant of coordination modes (Adler, 1995; Malone et al., 1999; Van de Ven et al., 1976). Since then, emerging bridging technologies (telecommunications, group technologies, and transportation) have enabled new forms of coordination. Further research is needed to relate the emerging technological and organizational coordination solutions to the types of interdependence recognized in this paper.

We have sought to provide research-based practical guidelines for companies and MNEs in managing the patterns of interdependencies that emerge in offshored, globally distributed, complex knowledge and information work. Managers involved in GDW need to understand the impact of global distribution on organizational performance. Our focus on work interdependencies and work design across global distances will resonate well here with MNEs involved by choice in GDW, given the upward trend in outsourcing, offshoring, and knowledge-intensive work. Indeed, as GDW and offshoring encompasses higher-end knowledge work, we will need to redesign both work and management practices to meet these new challenges. Research questions for future studies include: How does the outsourcing of knowledge-intensive work differ from the outsourcing of routine operational work? How does the offshore outsourcing of concrete manufacturing work, as in offshoring to China, differ from the offshoring of abstract knowledge work to China? How is the transition toward offshoring (or the reversing of earlier offshoring decisions) organized? How do distributed knowledge workers hand off work without losing sight and control of the larger projects and organizational processes? How can managers decide on which strategies to employ for avoiding, reducing, and/or enabling sticky interdependencies? These are among a few of the potential questions that future offshoring research can address. We believe our contribution has been to offer a revised typology for the design of work that is more salient for today's offshored and GDW. Given that our theories have not kept pace, it is no wonder that managers lack an up-to-date managerial model that can sufficiently guide and enable offshoring.

ACKNOWLEDGEMENTS

I acknowledge former Editor-in-Chief Arie Lewin and the three anonymous reviewers who helped us craft a theoretical argument that will hopefully impact on how offshored and globally distributed work is conceptualized and designed in the future. We also acknowledge FIU CIBER for their continued support of this project, Erasmus Research Institute for Management, the GDW Foundation, headquartered in Bangalore, India and its corporate partners, and the corporate executives in DBA program at the City University of Hong Kong, who gave us a chance to develop and test the ideas in the world of practice.

NOTES

[1]The designation of a location as "offshore", "nearshore", or "onshore" is in the eye of the beholder. The authors are indebted to David McCoy (www.gartner.com/research/fellows/asset_55353_1175.jsp), Gartner Fellow and Vice-President, for pointing out that "For Hawaii every place is offshore." In this age of true *multi*nationals (for a company to be truly multinational it has to be "multi" and not "mono" national) and global partnerships, designating one country as the "country of origin" to define "offshore" can be rather limiting. In many cases work originates from different sites, depending upon the phase the work is in.

[2]Depending upon the level of analysis, an actor performing a task can be either an individual, a computer, an organizational sub-unit, an organization, or a group of organizations (network).

[3]The focus of this paper is on task interdependence. Along with task uncertainty and size, task interdependence is considered a key determinant of choice of coordination modes. Thus it is important to precisely understand the differences in various types of inter-task interdependence before one can use this information to select and design appropriate coordination mechanisms.

[4]We recognize that some of these challenges can also exist within a "domestic" distributed work context, especially in large and culturally diverse countries such as India, or in regions such as the European Union. However, it is our contention that the geographical, temporal, cultural, regulatory, and

infrastructure gaps present in a globally distributed work context magnify the gaps and their consequences and challenges.

[5]The often used term "paper shuffling" is an apt, though somewhat negative, description of this process.

[6]The process of theory evaluation and construction in this paper is similar to Karl Weick's method of "theory construction as disciplined imagination" (Weick, 1989). Following Weick, we first build a set of representations of the possible work patterns in GDW from published reports, first-hand observations, interviews, and scenarios. We use these representations (see Table 1) to first evaluate the extant theory, and construct a problem statement (in our case the requirements for revising the classic typology). Next we refine the extant theory (i.e., suggest a solution to the problem statement), and then examine the appropriateness of the theoretical solution by conducting "thought experiments" with both the scenarios in Table 1, as well as in the design of two decision situations in the section on application of the revised taxonomy.

[7]To be precise, Mintzberg (1979) interprets pooled interdependence somewhat differently from Thompson (1967) and Van de Ven et al. (1976). Whereas Thompson and Van de Ven et al. define pooled interdependence as the pooling of task *outcomes* (i.e., the use of pool as a verb), Mintzberg's interpretation is that, in the pooled condition, interdependence arises because actors are sharing the same pool of resources (i.e., pool as a noun referring to *inputs*). Grandori (1997) is even more explicit in defining pooled interdependence as that which arises from sharing a pool of resources. She goes on to point out that this resource-based interdependence is likely to be as intense as team interdependence, and thus needs to be placed higher on the scale of interdependencies. While both views provide complementary interpretations of pooled interdependence, we choose to focus upon the more commonly accepted traditional interpretation of Thompson and Van de Ven et al.: that is, pooling of outcomes, and not input resources. This is also consistent with the idea that we are focusing on task interdependencies and not resource interdependencies.

[8]Thompson (1967) refers to units as individual performers of a certain task. Van de Ven et al. (1976) use the word "unit" to denote a particular organizational unit that performs the task. We follow the latter, more general concept of a work unit. Thus in Figure 1 the circles represent a work unit, and the arrows between them task interdependencies.

[9]Grandori (1997) calls both sequential and reciprocal interdependence "transactional interdependence". She argues that both sequential and reciprocal interdependence are essentially related to a transaction. That is, the flows of the object of work across two action points are essentially similar, except for bidirectionality in reciprocal interdependence.

[10]The word "team" can have two different meanings. Van de Ven et al. (1976) use the term "team interdependence" as a descriptor of highly intense, simultaneous and joint dependence. However, "team" is also used to define an organization structure such as a group working together on a task (Katzenbach & Smith, 1993). With the second definition, work can potentially flow between team members in a sequential, reciprocal, or intense manner. In some cases, e.g., a call center, team members may even be independent of each other as in pooled interdependence. To avoid confusion, we use a more precise term – "intense interdependence".

[11]The scenarios presented here are simplified examples of real-world work cases observed during our 14-year-long study of globally distributed work. They have been simplified to reduce the complexity, while still retaining aspects needed to illustrate the case.

[12]The phrase "throw it over the wall" is often used in information systems development projects where outcomes of one project task or phase are "thrown over the wall" to the party performing the next task, without any consideration of whether the other party receives the outcomes or not, or whether the outcomes are understood.

[13]It may be argued that parts can have intrinsic value in themselves – for example, a diamond as part of a ring, or an inventory of automobile parts that can be sold either for maintenance or at the time of liquidation of the company. However, if we take the part in the context of the desired outcome, in the former case of a ring, a diamond cannot be worn on a finger by itself. Nor can an engine block be driven by itself.

[14]Williamson (1981) in turn refers to Thompson (1967) to define the idea of a transaction.

[15]The term transactional interdependence as defined here is also consistent with the origins of the term transaction as "trans" or across and "action", that is, something that goes across two actions.

[16]On the other hand, the interaction between an epicure and a sommelier or waiter at an *haute cuisine* restaurant is likely to be highly sticky.

[17]For the sake of simplicity, at this time we will assume a single actor for each site. However, the models in Figure 3 can easily be modified to show more than one actor per site.

[18]We are not implying that work design in the global distribution of non-sticky work is trivial. As current practice and research on global supply chain management clearly show, it includes complex issues of logistics, routing, regulation compliance, and so on. However, since in this paper our focus is on the effect of global distribution on interdependence, these issues can be considered as introducing additional tasks that are related to existing work tasks through the overall taxonomy of interdependence.

[19]Our recent discussions with SAP suggest that at this time SAP is also considering political and social criteria for R&D work design and allocation. For example, the Chinese division SAP has recently proposed that in parity with the Waldorp and Palo Alto research units, they too would like to establish and staff a pure research unit in Shanghai. While at present there is no direct economic justification for this unit, a combination of local pride and pressure from the Chinese authorities to locate more R&D in China has resulted in an approval for setting up a research unit in Shanghai. The consequences and the actual value/costs of this unit will become known only after it becomes operational in 2008.

REFERENCES

Abel, M. 1990. Experiences in an exploratory distributed organization. In J. Galegher, R. E. Kraut and C. Egido (Eds), *Intellectual teamwork: Social and technological foundations of cooperative work*: 489–510. Hillsdale, NJ: Lawrence Erlbaum Associates.

Adler, P. S. 1995. Interdepartmental interdependence and coordination: The case of the design/manufacturing interface. *Organization Science*, 6(2): 147–167.

Alchian, A. A., & Demsetz, H. 1972. Production, information costs, and economic organization. *American Economic Review*, 62(5): 777–795.

Allen, T. J. 1984. *Managing the flow of technology*. Cambridge, MA: MIT Press.

Bechky, B. A. 2003. Sharing meaning across occupational communities: The transformation of understanding on a production floor. *Organization Science*, 14(3): 312–330.

Bell, B. S., & Kozlowski, S. W. J. 2002. A typology of virtual teams: Implications for effective leadership. *Group & Organization Management*, 27(1): 14–49.

Biggiero, L., & Sevi, E. 2005. *The effects of relational complexity on group performance*, Paper presented at 6th European Congress on Systems Sciences (http://www.afscet.asso.fr/resSystemica/Paris05/biggiero.pdf). Paris.

Boland, R. J. 1991. Information systems use as a hermeneutic process. In H.-E. Nissen, H. H. Klein and R. Hirschheim (Eds), *Information systems research: Contemporary approaches & emergent traditions*: 439–458. New York: North-Holland.

Bradach, J. L. 1998. *Franchise organizations*. Boston, MA: Harvard Business School Press.

Bryant, T. J., Vertinsky, I., & Smart, C. 2007. Globalization and international communicable crises: A case study of SARS. In D. E. Gibbons (Ed.), *Communicable crises: Prevention, response, and recovery in the global arena*: 265–300. Charlotte, NC: Information Age Publishing.

Burns, T., & Stalker, G. M. 1961. *The management of innovation*. London: Tavistock Publications.

Carlile, P. R. 2004. Transferring, translating, and transforming: An integrative framework for managing knowledge across boundaries. *Organization Science*, 15(5): 555–568.

Carmel, E. 1999. *Global software teams: Collaborating across borders and time zones*. Englewood Cliffs, NJ: Prentice-Hall.

Carmel, E., & Tjia, P. 2005. *Offshoring information technology sourcing and outsourcing to a global workforce*. Cambridge: Cambridge University Press.

Ciborra, C. U., & Patriotta, G. 1996. Groupware and teamwork in new product development: The case of a consumer goods multinational. In C. U. Ciborra, W. J. Orlikowski, A. Failla, G. Patriotta, T. K. Bikson, N. T. Suetens and E. Wynn (Eds), *Groupware & teamwork: Invisible aid or technical hindrance?*: 121–142. Chichester: John Wiley.

Couto, V., Mani, M., Lewin, A. Y., & Peeters, C. 2006. *The globalization of white-collar work: The facts and fallout of next-generation offshoring*, The Fuqua School of Business: Booz/Allen/Hamilton and Offshoring Research Network (http://offshoring.fuqua.duke.edu/).

Cramton, C. D. 2001. The mutual knowledge problem and its consequences for dispersed collaboration. *Organization Science*, 12(3): 346–371.

Crowston, K. 1997. A coordination theory approach to organizational process design. *Organization Science*, 8(2): 157–175.

Engeström, Y., Engeström, R., & Kärkkäinen, M. 1995. Polycontextuality and boundary crossing in expert cognition: Learning and problem solving in complex work activities. *Learning and Instruction*, 5(4): 319–336.

Faraj, S., & Sproull, L. 2000. Coordinating expertise in software development teams. *Management Science*, 46(12): 1154–1568.

Feldman, M. S., & Pentland, B. T. 2003. Reconceptualizing organizational routines as a source of flexibility and change. *Administrative Science Quarterly*, 48(1): 94–118.

Galbraith, J. R. 1973. *Designing complex organizations*. Reading, MA: Addison-Wesley.

Grandori, A. 1997. An organizational assessment of interfirm coordination modes. *Organization Studies*, 18(6): 897–925.

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

Herbsleb, J. D., & Mockus, A. 2003. An empirical study of speed and communication in globally-distributed software development. *IEEE Transactions on Software Engineering*, 29(3): 481–494.

Hinds, P., & Bailey, D. E. 2003. Out of sight, out of sync: Understanding conflict in distributed teams. *Organization Science*, 14(6): 615–632.

Kaiser, K. M., & Hawk, S. 2004. Evolution of an offshore software development: From outsourcing to cosourcing. *MIS Quarterly Executive*, 3(2): 69–81.

Katzenbach, J. R., & Smith, D. K. 1993. *The wisdom of teams: Creating the high-performance organization*. Boston, MA: McGraw-Hill/Harvard Business School Press.

Kiesler, S., Wholey, D., & Carley, K. M. 1994. Coordination as linkage: The case of software development teams. In H. Harris, (Ed.), *Organizational linkages: Understanding the productivity paradox*: 214–239. Washington, DC: National Academy Press.

Kraut, R. E., & Galegher, J. 1990. Patterns of contact and communication in scientific research collaboration. In J. Galegher, R. E. Kraut and C. Egido (Eds), *Intellectual teamwork: Social and technological foundations of cooperative work*: 149–171. Hillsdale, NJ: Lawrence Erlbaum Associates.

Kraut, R. E., & Streeter, L. A. 1995. Coordination in software development. *Communications of the ACM*, 38(3): 69–81.

Kumar, K., van Fenema, P. C., & Von Glinow, M. A. 2005. Intense collaboration in globally distributed work teams: Evolving patterns of dependencies and coordination. In D. L. Shapiro, M. A. Von Glinow and J. L. C. Cheng (Eds), *Managing multinational teams: Global perspectives*: 127–154. Oxford: Elsevier/JAI.

Kurland, N. B., & Egan, T. D. 1999. Telecommuting: Justice and control in the virtual organization. *Organization Science*, 10(4): 500–513.

Leidner, R. 1993. *Fast food, fast talk: Service work and the routinization of everyday life*. Berkeley, CA: University of California Press.

Lewin, A. Y., & Peeters, C. 2006a. Offshoring work: Business hype or the onset of fundamental transformation? *Long Range Planning*, 39(3): 221–239.

Lewin, A. Y., & Peeters, C. 2006b. The top-line allure of offshoring. *Harvard Business Review*, 84(3): 22–24.

Malhotra, A., Majchrzak, A., Carman, R., & Lott, V. 2001. Radical innovation without collocation: A case study at Boeing-Rocketdyne. *MIS Quarterly*, 25(2): 229–249.

Malone, T. W., Crowston, K., Lee, J., & Pentland, B. 1999. Tools for inventing organizations: Towards a handbook of organizational processes. *Management Science*, 45(11): 65–78.

March, J. G., & Simon, H. A. 1958. *Organizations*. New York: Wiley.

McCann, J. E., & Galbraith, J. R. 1981. Interdepartmental relations. In P. C. Nystrom and W. H. Starbuck, (Eds), *Handbook of organizational design*: 60–84. New York: Oxford University Press.

Meadows, C. J. 1996a. Globalizing software development. *Journal of Global Information Management*, 4(1): 5–14.

Meadows, C. J. 1996b. *Globework: Creating technology with international teams*, Thesis, Harvard Business School, Harvard University, Boston.

Mintzberg, H. 1979. *The structuring of organizations*. Englewood Cliffs, NJ: Prentice Hall.

Mohrman, S. A., Klein, J. A., & Finegold, D. 2003. Managing the global new product development network: A sensemaking perspective. In C. B. Gibson and S. G. Cohen (Eds), *Virtual teams that work: Creating conditions for virtual team effectiveness*: 37–58. San Francisco: Jossey-Bass.

Murtha, T. P., Kenney, M., & Massini, S. 2006 Call for papers, special issue of *Journal of International Business Studies*: Offshoring Administrative and Technical Work: Implications for Globalization, Corporate Strategies, and Organizational Designs.

Nemiro, J. E. 2000. The glue that binds creative virtual teams. In Y. Malhotra (Ed.), *Knowledge management and virtual organizations*: 101–123. Hershey, PA: Idea Group Publishing.

Ngwenyama, O. K., & Lee, A. S. 1997. Communication richness in electronic mail: Critical social theory and the contextuality of meaning. *MIS Quarterly*, 21(2): 145–167.

Parsons, T. 1956a. Suggestions for a sociological approach to the theory of organizations – I. *Administrative Science Quarterly*, 1(1): 63–85.

Parsons, T. 1956b. Suggestions for a sociological approach to the theory of organizations – II. *Administrative Science Quarterly*, 1(2): 225–239.

Pentland, B. T., & Rueter, H. H. 1994. Organizational routines as grammars of action. *Administrative Science Quarterly*, 39(3): 484–510.

Purser, R. E., & Montuori, A. 1995. Varieties of knowledge work experience: A critical system inquiry into the epistemologies and mindscapes of knowledge production. In M. M. Beyerlein, D. A. Johnson and S. T. Beyerlein (Eds), *Advances in Interdisciplinary Studies of Work Teams*: 117–161. Greenwich, CT: JAI Press.

Rottman, J. W., & Lacity, M. C. 2006. Proven practices for effectively offshoring IT work. *Sloan Management Review*, 47(3): 56–63.

Sabbagh, K. 1996. *Twenty-first century jet: The making and marketing of the Boeing 777*. New York: Scribner.

Shapiro, D. L., Von Glinow, M. A., & Cheng, J. L. C. 2005. *Managing multinational teams: Global perspectives*. Oxford: Elsevier/JAI.

Simon, H. A. 1950. *Administrative behavior*. New York: Free Press.

Stinchcombe, A. L. 1959. Bureaucratic and craft administration of production: A comparative study. *Administrative Science Quarterly*, 4(2): 168–187.

Stinchcombe, A. L. 1990. *Information and organizations*. Berkeley, CA: University of California Press.

Szulanski, G. 1996. Exploring internal stickiness: Impediments to the transfer of best practice within the firm. *Strategic Management Journal*, 17(Winter special issue): 27–43.

Szulanski, G. 2003. *Sticky knowledge: Barriers to knowing in the firm*. London: Sage.

Teagarden, M. B., Von Glinow, M. A., Bowen, D., Frayne, C., Nason, S., Huo, P., Milliman, J., Arias, M., Butler, M., Kim, N., Scullion, H., & Lowe, K. 1995. Toward a theory of comparative management research: An idiographic case study of the Best International Human Resources Management Project. *Academy of Management Journal*, 38(5): 1261–1287.

Thompson, J. D. 1967. *Organizations in action*. New York: McGraw-Hill.

Thunderbirds. 1996. *Thunderbirds: Legends of the sky*. Los Angeles: Espectra Media.

Van de Ven, A. H., Delbecq, A. L., & Koenig Jr., R. 1976. Determinants of coordination modes within organizations. *American Sociological Review*, 41(2): 322–338.

Victor, B., & Blackburn, R. S. 1987. Interdependence: An alternative conceptualization. *Academy of Management Review*, 12(3): 486–498.

Vlaar, P. W. L., van Fenema, P. C., & Tiwari, V. 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(2): 227–256.

Von Glinow, M. A., Shapiro, D., & Brett, J. 2004. Can we talk and should we? Managing emotional conflict in multicultural teams. *Academy of Management Review*, 29(4): 578–592.

Von Glinow, M. A., Drost, E. A., & Teagarden, M. B. 2005. Counterintuitive findings in IHRM research and practice: When is a best practice not best for practice? In M. Losey, S. Meisinger and D. Ulrich (Eds), *The future of human resource management: 64 thought leaders explore the critical HR issues of today and tomorrow*: 392–399. New York: Wiley.

von Hippel, E. 1994. "Sticky information" and the locus of problem solving: Implications for innovation. *Management Science*, 40(4): 429–439.

von Hippel, E. 1998. Economics of product development by users: The impact of "sticky" local information. *Management Science*, 44(5): 629–644.

Wageman, R. 1995. Interdependence and group effectiveness. *Administrative Science Quarterly*, 40(1): 145–180.

Weick, K. E. 1989. Theory construction as disciplined imagination. *Academy of Management Review*, 14(4): 516–531.

Weisband, S. 2002. Maintaining awareness in distributed team collaboration: Implications for leadership and performance. In P. Hinds and S. Kiesler (Eds), *Distributed work: New ways of working across distance using technology*: 311–333. Cambridge, MA: MIT Press.

Williamson, O. E. 1981. The economics of organization: The transaction cost approach. *American Journal of Sociology*, 87(3): 548–577.

Winter, S. G., & Szulanski, G. 2001. Replication as strategy. *Organization Science*, 12(6): 730–743.

Yourdon, E., & Constantine, L. 1979. *Structured design: Fundamentals of a discipline of computer programming and design*. Englewood Cliffs, NJ: Prentice Hall.

Zollo, M., & Winter, S. G. 2002. Deliberate learning and the evolution of dynamic capabilities. *Organization Science*, 13(3): 339–351.

ABOUT THE AUTHORS

Kuldeep Kumar is a founder and co-chair of the Globally Distributed Work Foundation, headquartered in Bangalore, India. He is the associate director of the DBA program at City University of Hong Kong and currently holds professorial appointments at Florida International University, and City University of Hong Kong. He was born in India and completed his BTech at IIT, Kanpur, India. He received his MBA and PhD from McMaster University in Canada (e-mail: kumark@fiu.edu).

Paul C. van Fenema is an Associate Professor at the Netherlands Defense Academy and holds a part-time position at Tilburg University. He held positions at RSM Erasmus University and Florida International University. His research interests include global organizations, coordination, and knowledge management. He was born in the Netherlands, and received his PhD from Erasmus University (e-mail: pc.v.fenema@nlda.nl).

Mary Ann Von Glinow is the Knight Ridder Eminent Scholar Chair in International Management, and Director of the Center for International Business Education and Research at Florida International University. She was the 2007 Program Chair of the AIB's prestigious Frontiers Conference, and in 2006 Program Chair for AIB Beijing. Her PhD is in Management Science from the Ohio State University. Dr. Von Glinow was the 1994–95 President of the Academy of Management and is a Fellow of the Academy of Management, the Academy of International Business, and the Pan Pacific Business Association. Her current research is on the global distribution of work, principally to China and India (e-mail: vonglino@fiu.edu).

Accepted by Arie Y Lewin, Editor-in-Chief, 28 January 2008. This paper has been with the authors for two revisions.