DEEPENDRA MOITRA

Globalization of R&D

Leveraging Offshoring for Innovative Capability and Organizational Flexibility

GLOBALIZATION OF R&D: LEVERAGING OFFSHORING FOR INNOVATIVE CAPABILITY AND ORGANIZATIONAL FLEXIBILITY

Globalization of R&D: Leveraging offshoring for innovative capability and organizational flexibility

Globalisering van R&D: innovatie-vermogen en organisatie-flexibiliteit door middel van offshoring

Thesis

to obtain the degree of Doctor from the
Erasmus University Rotterdam
by command of the
rector magnificus

Prof.dr. S.W.J. Lamberts

and in accordance with the decision of the Doctorate Board

The public defense shall be held on
Friday 5 December 2008 at 11:00 hrs

by

Deependra Moitra
born in Seedhi, India

ERASMUS UNIVERSITEIT ROTTERDAM

Doctoral Committee

Promoter:
Prof.dr. K. Kumar

Other members:
Prof.dr.ir. J.C.M. van den Ende
Prof.dr. S.J. Magala
Prof.dr. J. van Hillegersberg

Erasmus Research Institute of Management – ERIM
Rotterdam School of Management (RSM)
Erasmus School of Economics (ESE)
Erasmus University Rotterdam
Internet: http://www.erim.eur.nl

ERIM Electronic Series Portal: http://hdl.handle.net/1765/1

ERIM PhD Series in Research in Management, 150
Reference number ERIM: EPS-2008-150-LIS
ISBN/EAN 978-90-5892-184-0

Design: B&T Ontwerp en advies www.b-en-t.nl
Print: Haveka www.haveka.nl

For Nandita and Ilina

PREFACE

The last two decades have witnessed the emergence and intensification of offshoring of R&D—a new phenomenon as well as a new global organizational form, which is increasingly becoming central to the competitiveness of high technology firms. Rooted in the notion of comparative advantage, offshoring of R&D involves disaggregation and global distribution of the firm's R&D value chain activities to leverage innovation capacity of low-cost countries. Characteristically different from market- and technology-seeking globalization of R&D, offshoring is motivated by the intertwining competitive needs to gain efficiency and access knowledge resources. This doctoral dissertation represents an attempt to systematically understand the terrain of the phenomenon of offshoring of R&D and its linkage with firm competitiveness.

Ever since graduating from the engineering school back in 1992, I have been operating in the midst of accelerating pace of offshoring of R&D. I have been fortunate to have had the opportunity to witness the phenomenon unfold first-hand and also manage large offshore R&D operations at some of the leading global high technology companies. However, I found that offshoring of R&D is generally viewed as a vehicle for reducing costs and is often approached very tactically. Over the years, the steady growth in the quantum of offshore R&D activities has fueled my curiosity to look beyond structural cost savings and understand the strategic impact of offshoring of R&D on firm competitiveness. Towards this, I found the pursuit of doctoral research to be most opportune to examine the phenomenon of offshoring of R&D and acquire a comprehensive understanding of how it could endow high technology firms with strategic advantages.

Pursuing doctoral research alongside a full-time and demanding job has not been easy, and undoubtedly this dissertation would not have become a reality without the generous encouragement and support of many people. As a matter of fact, this doctoral dissertation is a confluence of many elements—my own intense desire to do a Ph.D.; Professor Kuldeep Kumar—my advisor, who greatly nurtured and supported my interest in scholarly research; Professor Han van Dissel—the former dean of Rotterdam School of Management, who believed in the potential of this research; several companies that participated in this study; my former employer, Infosys Technologies, which supported my doctoral work while I was there; and, of course, my wife, Nandita, and our daughter, Ilina, who gave me so much and asked for so little.

I first met Kuldeep Kumar back in May 2004 and he has ever since become more than a research advisor to me—a mentor, a friend, and above all, someone whom I turn to whenever I need any advise. Professor Kumar gave me the guidance, freedom, and encouragement I needed along the way to successfully achieve my research goals, took active interest in nurturing my scholarly interests, generously gave me his time, and, above all, 'understood' me. Without the active interest of Professor Kumar, this PhD dissertation would not have become a reality and for this, I owe a very special debt to him. I also wish to take this opportunity to thank Professor Kumar's wife, Veronica Kumar, who very graciously supported me whenever I placed demands on Professor Kumar's time, including on weekends and often during odd hours.

Sincere thanks are due to my doctoral committee members—Prof. Jan van den Ende, Prof. S. J. Magala, Prof. Jos van Hillegersberg, and Prof. Frank Go, who very kindly supported my interest in pursuing doctoral research and provided very valuable comments on the draft of my dissertation. In addition, I would like to thank several people without whose kind help and support I could not have completed this dissertation: Peter Pruzan, Amrit Tiwana, Ashok Gupta, Nikhil Mehta, Nandan Nilekani, Praveen Sahani, Jai Ganesh, Asit Pant, Sharad Sharma, Bob Hoekstra, Martin Prinz, Subramanian Ramanathan, Vinay Tiwari, G. Venkatesh, Balu Angaian, and Kalyan Kumar Banerjee. I also wish to acknowledge the excellent support received from Olga Novikova of the Erasmus Research Institute of Management.

Finally, and most importantly, my endeavor to pursue doctoral research was nourished by my wife, Nandita, and our daughter, Ilina, who provided constant encouragement and unconditional support to me over the last 4 years. In fact, my goal to earn a Ph.D. became a goal for both of them as well, and while Nandita served as the backbone for my effort, Ilina taught me to smile as I struggled my way through to the completion of this dissertation. I am ever thankful to both of them for making it so easy for me to pursue my long cherished dream of earning a Ph.D.

Bangalore, India — Deependra Moitra
October 9, 2008

CONTENTS

LIST OF FIGURES

List of Tables

CHAPTER 1
INTRODUCTION

INNOVATION AND FLEXIBILITY are central to the competitiveness of high technology firms (Teece, *et. al.*, 1997; Volberda, 1997; Bahrami, 1992; EIU, 2003; Ohmae, 2005). While innovation forms the primary fuel for continued firm growth in high technology industries (Nonaka and Takeuchi, 1995; Myers and Rosenbloom, 1996), flexibility is a crucial requirement for effective competitive action (Bahrami and Evans, 1989; Volberda, 1996). Indeed, innovative capability and organizational flexibility are the two most important capabilities for competitive success of high technology firms. Innovative capability is the ability of a firm to generate product, process and technological innovations (Kogut and Zander, 1992; Leonard, 1995; Nonaka and Takeuchi, 1995), whereas organizational flexibility refers to a firm's adaptive capacity that allows it to respond effectively to changes in its business environment (Bahrami, 1992; Volberda, 1998). Research and development (R&D) is a key source of innovative capability for high technology firms (Lengnick–Hall, 1992; Myers and Rosenbloom, 1996), and leveraging different organizational forms, among other things, constitutes their quest for achieving organizational flexibility (Lewin and Volberda, 1999; Galunic and Eisenhardt, 2001).

In recent years, a new phenomenon termed as offshoring of R&D has emerged that is altering the way high technology firms organize and manage R&D (UNCTAD, 2004b; UNCTAD, 2005; Inkpen and Ramaswamy, 2006; Bardhan, 2006; Engardio, 2006b; Cohen, 2007). Offshoring of R&D refers to location or migration of R&D activities by a firm to another low-cost country to access knowledge resources and harness differential cost structures (Jaffee, 2004; Engardio, 2004; Friedman, 2005; Hagel and Brown, 2005; Cohen, 2007; Mudambi, 2007; Jensen and Pedersen, 2007). Although offshoring of R&D may be interpreted as a part of the broader phenomenon of globalization of R&D, the economic and structural considerations underlying offshoring of R&D differ fundamentally from the traditional globalization of R&D (Inkpen and Ramaswamy, 2006; Bardhan, 2006; Cohen, 2007; Mudambi, 2007). While numerous reports indicate a growing trend towards offshoring of R&D (EIU, 2003; EIU, 2004b; UNCTAD, 2004b; UNCTAD, 2005), scholarly research examining the phenomenon is yet to develop (Bardhan, 2006). Offshoring of R&D is both a new trend in globalization and a new organizational form. The objective of this research is to generate a comprehensive, grounds-up understanding of the phenomenon of offshoring of R&D and its link with firm innovative capability and organizational flexibility—the two most important organizational capabilities for high technology enterprises.

1.1 R&D AND HIGH TECHNOLOGY FIRMS

> *Free market economies cycle up and down. The bulls and bears come and go. But high-tech companies that plan to be around for a while must invest steadily in research and development, or risk being swept away in the next wave of innovation. (Goldstein, 2002)*

R&D is a major contributing factor to global competitiveness of high technology firms (Franko, 1989). Indeed, R&D has been found to be leading to long-term profitability of firms as also better profit margins and higher stock prices (Henry, 2006; Mansfield, 1981). In industry, the primary role of R&D is to drive business growth and profitability by developing new products and processes, improving existing products, and generating new learning and knowledge to develop a portfolio of technological capabilities (Ettlie, 2006; Forbes and Wield, 2002; Ganguly, 1999; Roussel, *et. al.*, 1991). 'Research' implies an orderly approach to exploration of new knowledge or to advance knowledge. In industry, the goal of research is to produce knowledge applicable to a company's business needs that will enable the company to achieve technological competitiveness and lay the foundations for new products and processes. 'Development' can be described as the process by which the output of 'Research' is leveraged to develop goods or services for commercial purposes (Ganguly, 1999; Roussel, *et. al.*, 1991).

R&D is a multifaceted activity and there is no common definition of R&D. Generally, R&D is defined in terms of three generic activities: 'Basic Research,' which is aimed at original investigations for the advancement of scientific knowledge without specific commercial objectives; 'Applied Research,' which implies original research undertaken with definite commercial objectives; and 'Development,' where the focus is on development and extension of products, processes and services (Ettlie, 2006; OECD, 2002). R&D activities can also be classified as incremental R&D, radical R&D, and fundamental R&D. Incremental R&D (small 'r' and big 'D') aims to deliver small advances in technology, typically based on an existing and established foundation of technological knowledge. Radical R&D (large 'R' and large 'D') involves discovery of new knowledge targeted at specific commercial goal, whereas fundamental R&D (large 'R' and no 'D') has no commercial alignment (Roussel, *et. al.*, 1991).

In industrial R&D, however, there is no hierarchy of importance in the contributions of 'R' and 'D' (Roussel, *et. al.*, 1991). Moreover, distinguishing between the boundaries of R and D is not easy in practice and, therefore, researchers have tended to look at R&D as one unit rather than distinct functions of 'R' and 'D'. This is also because data on the whole of R&D are more easily available than separately for 'R' and 'D' (Iansiti, 1998). In industrial R&D, the emphasis largely is on development, which is estimated to consume as much as 70-90% of the R&D budget (Jaruzelski, *et. al.*, 2005; Goldstein, 2002). In this dissertation, following Matheson and Matheson (1998), the term R&D in employed in the broadest sense to mean any technologically related activity that has the potential to renew or extend present business or generate new ones, including competency development, technological innovation, and product or process development.

With increasing intensity of competition, the role of R&D has become more pronounced in high technology industries since the dynamism in the business environment requires continuous renewal and refreshing of technological competencies (Chiesa, 2001). New technologies and customer preferences are rapidly emerging and changing, and the diversity and complexities of technologies that firms need for their competitive pursuits is also increasing. However, R&D is an enormously expensive enterprise and is characteristically an uncertain activity (Balthasar, *et. al.*, 1978; Mansfield, 1981). While there has been a steady rise in R&D spending, the cost of R&D has also been proportionately growing (Jaruzelski, *et. al.*, 2005). As a result, high technology companies are compelled to look for ways to achieve efficiency, quality and flexibility to generate short-term, incremental innovations while simultaneously shortening product development time, cutting costs, and doing more with less (Gupta and Wilemon, 1996; Roush, 2001; Downey, *et. al.*, 2003; Jaruzelski, *et. al.*, 2005; McGregor, 2006).

The rising competitive pressures resulting from evolving competitive dynamics have significantly influenced the forms and practices of R&D management (Amidon Rogers, 1996; Miller and Morris, 1999; Jaruzelski, *et. al.*, 2005). As a result, more and more R&D is globally distributed as well as vertically disintegrated (Roberts, 2001; Downey, *et. al.*, 2003; Ayers, 2005). Flexibility has also emerged as a key competitive imperative due to growing pace of innovation, increasing market and technological uncertainties, and possible risks of technological obsolescence that may arise due to over commitment to any particular technologies. Whilst pursuing a diversified R&D portfolio may endow organizational flexibility to a firm, the costs could be prohibitive (Buckley, 2003). High technology firms are increasingly going beyond not only their home countries but also their organizational boundaries for innovative capability and organizational flexibility—a trend that began to unfold almost three decades ago but has intensified in recent years (Goldstein and Hira, 2004).

1.2 R&D AND GLOBALIZATION

Globalization has become the most important economic phenomenon of this century. "Globalization is the process by which the world's economy is transformed from a set of national and regional markets into a set of markets that operate without regard to national boundaries" (Fraser and Oppenheim, 1997). The profound impact of globalization on businesses, societies, and cultures has stirred the imagination of its observers who have variously labeled the development as "Borderless World" (Ohmae, 1994), "World is Flat" (Friedman, 2005), etc. The increasing pervasiveness of industry globalization could be attributed to several drivers. These include market factors (access to global customers, emerging markets, shortening product life cycle, etc.), economic factors (search for efficiency, economies of scale and scope, cost differentiation, etc.), competitive factors (access to knowledge, competitive interdependence, comparative economics, etc.), and environmental factors (rate of technological change, ICT infrastructures, etc.) (Yip, 1992; Govindarajan and Gupta, 2001; Inkpen and Ramaswamy, 2006). Thus, globalization in industry could be resource-seeking, market-seeking, efficiency-seeking, and asset-seeking (Cohen, 2007).

Globalization of business has caused a remarkable decomposition of corporate functions, ranging from R&D and manufacturing to sales and marketing. It has now become common for a company to locate its business functions (including R&D) across national borders (Ohmae, 2005). Historically, R&D has been amongst the least globalized of corporate functions due to its embededdness in the home environment and 'stickiness' which arises from its tacit and complex nature, making it difficult to fragment and distribute (Karlsson, 2006). Moreover, by concentrating R&D in their home country locations, firms achieved economies of scale and scope, and also alleviated concerns regarding know-how and intellectual property protection (Chiesa, 2001). However, over the years, firms have increasingly globalized their R&D as indicated by recent data on international trade and foreign direct investment (UNCTAD, 2005; UNCTAD, 2006). Modularization of technologies, availability of ICT infrastructure, and reduced trade barriers are some of the key factors that have facilitated such global expansion of R&D (UNCTAD, 2004a).

Traditionally, firms have globalized R&D to either cater to local market opportunities, i.e., market-seeking R&D globalization, or to tap into centers of technological excellence beyond their home countries, i.e., technology-seeking R&D globalization (Cantwell, 1989; Håkanson and Nobel, 1993a; Håkanson and Nobel, 1993b; von Zedtwitz and Gassmann, 2002; Cohen, 2007). It is also common for firms to expand their R&D globally through acquisition of firms located overseas or by entering into an alliance with a foreign firm, i.e., asset-seeking R&D globalization (Murray, 2001; Oxley and Sampson, 2004). The topic of R&D globalization has received considerable attention from scholars who have examined the phenomenon from a macro as well as micro perspective (e.g., Cantwell, 1989; Bartlett and Ghoshal, 2002). There are many strands of the literature on R&D globalization (see Chapter 2 for a review) that explore various aspects of the phenomenon and encompass a range of theoretical and empirical studies.

However, in the context of this research, a few remarks on the R&D globalization literature are noteworthy. First of all, most of the literature on R&D globalization has developed in the context of multinational enterprises (MNEs) and largely concerns market-seeking, technology-seeking, or asset-seeking motives of firms (Bartlett and Ghoshal, 2002; Ghoshal and Westney, 2005; Buckley, 2003; Narula and Zanefi, 2005). Discussions of efficiency-seeking and/or knowledge resource-seeking motives that underlie offshoring of R&D is absent in the literature. Second, despite emphasis on the importance of studying organizational and management processes (Cheng and Bolon, 1993), a large proportion of the R&D globalization literature deals with macro-economic and cross-sectional perspectives (Gassmann and von Zedtwitz, 1999; Gerybadze and Reger, 1999). Finally, the research linking globalization of R&D and firm innovative capability is still scant (Venaik, *et. al.*, 2005; Kotabe, *et. al.*, 2007), whereas investigation of organizational flexibility in the context of R&D globalization is non-existent.

1.3 THE PHENOMENON OF OFFSHORING OF R&D

Whilst R&D continues to occupy a position high up in the hierarchy of corporate priorities, the global intensification of competition has changed the way R&D is organized and managed by high technology firms. Shorter R&D project cycle times, increasing global competition for talent, the diversity and complexities of technologies, and rising cost of R&D have necessitated firms to look for ways to manage R&D more efficiently and effectively. Particularly, containing R&D costs without compromising the quality and quantity of R&D has emerged as a top corporate priority (EIU, 2003). These new competitive requirements have accelerated the process of R&D globalization and led to the emergence of offshoring as a new vehicle for value creation. Offshoring of R&D transcends beyond specific markets and focuses on value creation by mobilizing and integrating globally distributed knowledge resources and competencies to cope with technological diversity and complexities, and to achieve efficiency, flexibility and enhanced innovation performance (Doz, *et. al.*, 2001; UNCTAD, 2005).

The term ‘offshore R&D’ has been often used interchangeably with ‘global R&D’ in the extant literature to simply imply location of R&D outside of the home country (Florida, 1997; Bartlett and Ghoshal, 2002; Narula and Zanefi, 2005). However, in recent times the term ‘offshoring of R&D’ has assumed a new and specific meaning, and refers to migration or location of R&D activities by a firm from one location to another low-cost country with the objective to access skilled technical resources and exploit differential cost structures (UNCTAD, 2004b; Carmel and Tjia, 2005; Hagel and Brown, 2005; Friedman, 2005; Engardio, 2006; Bardhan, 2006; Inkpen and Ramaswamy, 2006; Cohen, 2007). The term 'offshoring of R&D' does not yet have a universally accepted definition (Cohen, 2007). However, unlike the traditional globalization of R&D, which was driven by market- or technology- or asset-seeking motive, offshoring of R&D signifies the emergence of a relatively recent phenomenon that underlies efficiency- and knowledge resource-seeking motives of high technology firms (UNCTAD, 2005; Inkpen and Ramaswamy, 2006; Bardhan, 2006; Cohen, 2007; Jensen and Pedersen, 2007). The present research is concerned with this new meaning/phenomenon of offshoring of R&D.

Essentially, the phenomenon of offshoring of R&D is rooted in the notion of comparative advantage, which in turn influences the competitive advantage of a firm (McCann and Mudambi, 2005; Mudambi, 2007; Inkpen and Ramaswamy, 2006). Offshoring of R&D is part of the larger phenomenon of R&D globalization that has unfolded due to decomposition and global disaggregation of a firm's R&D value chain (McCann and Mudambi, 2005; Mudambi, 2007). Offshoring of R&D is motivated by the intertwining considerations of efficiency, and scale and capabilities of knowledge resources (Cohen, 2007). Even though the migration of jobs and disaggregation of the value chain as seen in offshoring of R&D parallels that observed in case of globalization of manufacturing, what separates offshoring of R&D as a new phenomenon is its knowledge-intensive nature and the economic transition to knowledge-based competition. Moreover, the theories of foreign trade, such as those of absolute and comparative advantage, that emphasize the immobility of factor endowments have been breached in the knowledge economy (Inkpen and Ramaswamy, 2006). Thus, offshoring of R&D not only involves new international division of labor but also signifies shifting geographies of innovation (Karlsson, 2006).

Offshoring of R&D essentially entails globally distributed R&D. The outputs of offshore R&D are simply integrated with the activities of the overall R&D value chain of a firm (Hagel and Brown, 2005; Bardhan and Jaffee, 2005; Cohen, 2007). In offshoring of R&D, the emphasis is not on serving markets, and usually an offshore R&D organization does not have a product-market mandate. Instead, technical talent and cost are emphasized in offshoring of R&D (Hagel and Brown, 2005). As illustrated in Figure 1, a firm may offshore its R&D activities by either establishing its own R&D operation or by outsourcing R&D work to another firm in a low-cost country. Thus, offshoring of R&D could involve Foreign Direct Investment (FDI) or a non-equity based approach to globalization (UNCTAD, 2004b; Carmel and Tjia, 2005). When R&D is offshored to a firm's own affiliate in another country, it is called intra-firm R&D offshoring and is commonly referred to as captive R&D offshoring. When R&D is offshored to another company, it represents offshore R&D outsourcing (UNCTAD, 2004b). Thus, offshoring of R&D not only involves transcending geographical boundaries, but it may also involve redrawing organizational boundaries.

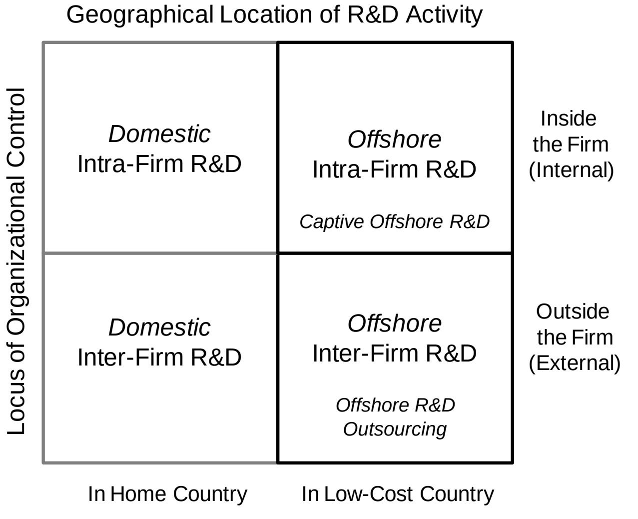


Figure 1.1: Intra-firm and Inter-firm Offshore R&D

The leap to offshoring of R&D has been enabled by the availability of robust ICT infrastructure and, quite importantly, modularity in products and production processes that permit decomposition of value chain and division of labor in a globally distributed manner. Consequently, R&D in microelectronics, software, pharmaceuticals and biotechnology has been increasingly offshored because they could be geographically delinked from production (UNCTAD, 2004a). Offshoring of R&D is fast gaining ground and is typically being hosted by developing countries that offer high quality but low cost talent pool (UNCTAD, 2005; Liu and Chen, 2003). A survey of multinational companies revealed that they were spending an average 18% of their R&D budget on offshoring in developing countries in 2002, which was expected to grow up to 30% by 2007 (UNCTAD, 2005).

Another recent survey of 186 of the world's largest corporations found that 77% of new R&D centers over the next three years would be set-up in emerging economies like India and China (Doz, *et. al.*, 2006). Even venture capitalists seem to show a preference for funding ventures that have built-in offshoring components (Bardhan, 2006). Various reports and surveys suggest that a major objective in offshoring of R&D is to leverage low-cost R&D resource pool to improve the speed, quality and volume of market relevant innovations (EIU, 2004a; EIU, 2004b; UNCTAD, 2005; Bardhan and Jaffee, 2005; Doz, *et. al.*, 2006; Lewin and Peeters, 2006). It also appears from the survey findings that while lower cost structures form the necessary condition for offshoring of R&D, availability of high quality and large scale of technical talent constitutes the sufficient condition (EIU, 2004b; UNCTAD, 2005).

1.4 RESEARCH PURPOSE AND QUESTIONS

There is a growing recognition that offshoring of R&D is a strategic necessity for high technology firms, for it can help expand a firm's competitive options (Carmel and Tjia, 2005; UNCTAD, 2004b). The business press and industry publications propagate a view that the benefits of offshoring of R&D go beyond just cost reduction and include innovation, speed, flexibility, and new revenues (e.g. Duga and Stutt, 2006). Operating effectively in the regime of rapid technological change demands greater flexibility in R&D and requires firms to possess a sizable number of R&D staff with a range of specialization (UNCTAD, 2005). Industry analysts argue that due to its variable cost structure, offshore R&D helps acquire the needed flexibility in R&D by providing access to a large capability pool and by serving as a 'low-cost safety valve' in dealing with demand fluctuations (Bhattacharya, 2004; Dehoff and Sehgal, 2006). According to Hagel and Brown (2005), offshoring of R&D is a powerful means to rapidly build and leverage technological capabilities to drive innovation.

While the business press has keenly followed the emergence and growth of offshoring of R&D (EIU, 2004a; UNCTAD, 2004a; UNCTAD, 2004b; Bhattacharya, 2004; UNCTAD, 2005; Engardio, 2006b), the scholarly research is yet to catch-up with the phenomenon. Although many scholars recognize that offshoring of R&D is a new and noteworthy phenomenon (Carmel and Tjia, 2005; Lewin and Peeters, 2006; Bardhan, 2006; Cohen, 2007; Mudambi, 2007; Jensen and Pedersen, 2007), there is hardly any academic discourse yet on offshoring of R&D. As discussed in the beginning of this chapter, innovative capability and organizational flexibility are the two most important organizational capabilities for high technology firms. In view of the rising propensity towards offshoring of R&D, understanding the link between offshore R&D and a firm's innovative capability and organizational flexibility assumes vital importance. However, an extensive literature review suggests that to date there has not been any systematic attempt to understand the link between offshoring of R&D and a firm's innovative capability and organizational flexibility. This could perhaps be due to the fact that the phenomenon of offshoring of R&D is a relatively recent one.

Although several scholars have examined the influence of globalization of R&D on the innovative capability of multinational corporations (e.g., Ghoshal and Bartlett, 2002; Nohria and Ghoshal, 1997; Persaud, 2005; Gupta and Govindarajan, 1991; Gupta and Govindarajan, 2000; Kotabe, *et. al.*, 2007; Narula and Hagedoorn, 1999; Murray, 2001; Oxley and Sampson, 2004), such studies do not fully correspond with the context and nature of offshoring of R&D. On the other hand, scholarly research that explores organizational flexibility in the context of R&D globalization is non-existent. Even though the extant literature often highlights organizational flexibility as a key benefit of R&D outsourcing, studies investigating R&D outsourcing in a cross-border context are not readily apparent. Thus, the absence of scholarly research on offshoring of R&D presents a compelling opportunity to investigate a new phenomenon that is rapidly gaining momentum and importance. The motivation for this research stems from such an opportunity.

Despite extensive coverage of offshoring of R&D in the business press, no documented understanding exists yet on how firms actually organize and manage offshore R&D. Further, it is not known as to what is the type and nature of R&D activities that is offshored. Moreover, while the business press has frequently mentioned efficiency, innovation, speed and flexibility as the key benefits of offshoring of R&D, a systematic understanding of how offshoring of R&D links with a firm's innovative capability and organizational flexibility does not exist. In addition, it is not known as to how the two modes of offshoring of R&D, namely intra-firm R&D offshoring and inter-firm R&D offshoring, are actually used by firms and how they compare and contrast with each other as regards their endowments of innovative capability and organizational flexibility. The purpose of this research, therefore, is to develop a comprehensive, grounds-up understanding of the phenomenon of offshoring of R&D, and make new theoretical and practical contributions.

To be precise, three specific objectives constitute the focus of this research:

1. To acquire an in-depth understanding of how firms organize and manage offshoring of R&D for innovative capability and organizational flexibility
2. To understand how offshoring of R&D links with a firm's innovative capability and organizational flexibility (Figure 1.2)
3. To develop a normative model of offshoring of R&D that can inform managerial practice

Commensurate with the research purpose, two interrelated research questions form the core of this study:

1A. How do firms organize and manage offshoring of R&D for innovative capability and organizational flexibility?

1B. How is offshoring of R&D associated with the firm's innovative capability and organizational flexibility?

In addition, there are three associated sub-questions that this research seeks to address:

2. Why do offshore R&D engagements differ in their endowments of innovative capability and organizational flexibility?
3. How can high technology firms optimally leverage offshoring of R&D for innovative capability and firm flexibility?
4. How does intra-firm offshoring of R&D compare and contrast with inter-firm offshoring of R&D as regards firm innovative capability and organizational flexibility?

Finally, as noted earlier, there is a need to properly define and characterize the phenomenon of offshoring of R&D and, therefore, this research seeks to provide answer to a fundamental question:

5. What is offshore R&D?

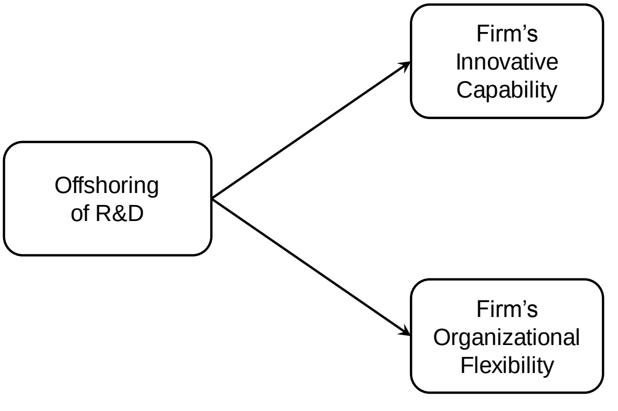


Figure 1.2: Focus of the Research

1.5 RESEARCH SCOPE

It is important to be clear on the boundaries of this study. The present research is concerned with those aspects of offshoring of R&D that occur once a firm has made its decision to offshore its R&D activities; hence, issues related to decision-making and location choice are not a consideration. As the research purpose and questions imply, this study aims to generate understanding and implications at the level of a firm. The focus of the study is on understanding the association between offshoring of R&D and a firm's innovative capability and organization flexibility. Towards that, the type and nature of R&D activities and the associated organizational and management processes are examined to discern the link between offshoring of R&D and a firm's innovative capability. It may be noted, however, that the scope of the research does not include an investigation of the source or development of innovative capability of an offshore R&D organization, which may come from the collective capability of its intellectual capital, its own learning trajectory and path dependence, and from its embededdness in a local innovation cluster. As regards organizational flexibility, the study seeks to find what is the type of flexibility offshoring of R&D confers upon a firm, and how firms leverage it for their competitiveness. Both intra-firm and inter-firm offshoring of R&D are covered in the scope of this research.

This study focuses on offshoring of software R&D, which is a major intangible innovation activity with a high R&D content. Currently, software dominates R&D across sectors and receives a bigger chunk of R&D budget. Moreover, amongst the offshored R&D activities, the volume of software R&D is significantly higher (Goldstein and Hira, 2004; Hira and Goldstein, 2005). Therefore, investigating the focal aspects of the phenomenon in the context of software R&D holds promise. The modularity of software systems aids easy division of labor (Chiesa, 2001) and because software is 'digital,' it can be easily transported by satellite transmission without incurring any significant transportation and communication costs (Krugman, 1991). Interestingly, however, software R&D is fundamentally different from R&D in other industries because the software R&D process differs from other technology R&D in that there is no tooling or manufacturing phase of the product development. Rather, when R&D is finished, the software is ready to use and sell (Tessler and Barr, 1997). However, the nature of software development is such that identifying its R&D component is difficult. Therefore, this research relies upon the guidelines provided by Frascati Manual (OECD 2002) for identifying software R&D projects (refer to Appendix I).

1.6 RESEARCH APPROACH

This research pivots on three bodies of literature, as depicted in Figure 1.3. First, the extant literature on R&D globalization is considered. The literature on R&D globalization is vast and has largely developed in the context of multinational enterprises. The R&D globalization literature also includes international R&D alliances, partnerships and outsourcing, and so these are also considered. Even though, as discussed earlier, offshoring of R&D differs from the traditional notion of globalization of R&D in a fundamental way, they are both globally distributed and involve pursuit of R&D activities to drive firm competitiveness. Hence, the rationale for considering the literature on globalization of R&D is to look for insights that may inform the present study. Second, since the focus of this study concerns innovative capability and organizational flexibility in offshoring of R&D, the relevant theories of organizational innovation and the literature on organizational flexibility are considered with a view to derive foundational insights for sense-making.

Third, the agency theory from the organizational economics literature and the dynamic capabilities perspectives from the strategic management literature are considered, for they provide the necessary theoretical underpinnings for this research. The principal-agent relationship stream of the agency theory offers a potentially useful framework for modeling the exchange relationship in offshoring of R&D (Eisenhardt, 1989a; Nohria and Ghoshal, 1997). The dynamic capabilities perspective is useful for studying firms that operate in high technology environments in which the equilibrium-based thinking of competitiveness is challenged (Teece, *et. al.*, 1997; Eisenhardt and Martin, 2000). Innovative capability and organizational flexibility form the core of a firm's dynamic capabilities (Eisenhardt and Martin, 2000; Wang and Ahmed, 2007). Therefore, incorporating the dynamic capabilities perspective is particularly appropriate for the present research. A conceptual lens developed by integrating insights from the literature review and theoretical underpinnings guides the empirical research.

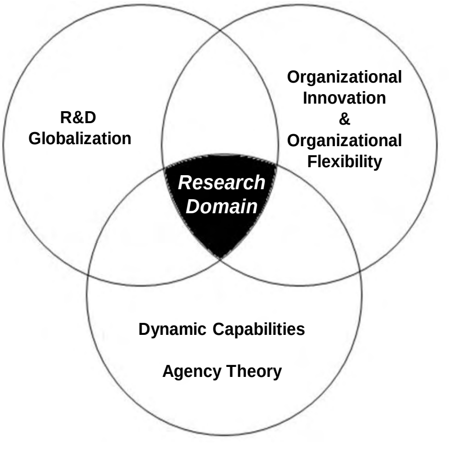


Figure 1.3: Research Domain and Theoretical Underpinnings

Employing an interpretive research approach, the empirical inquiry is operationalized through a multiple case study design with an inductive logic. In the absence of prior research on offshoring of R&D that could inform the present study, a grounds-up approach to building understanding is necessary. Hence, an inductive research approach is adopted (Eisenhardt, 1989b). The multiple case study design includes 8 case studies of intra-firm and inter-firm offshoring of R&D to explore several instances of the phenomenon in a variety of organizational settings so as to develop a well-rounded understanding and potentially wider applicability. The choice of the case study strategy is commensurate with the nature of research questions and the purpose of the research (Yin, 2003b). Since a grounds-up understanding about the phenomenon and its focal aspects can only be built by obtaining perspectives from people involved in offshoring of R&D within specific organizational contexts, an interpretive research approach is appropriate (Walsham, 1995; Prasad and Prasad, 2002). Such an approach not only allows an understanding of the structure, context and the underlying processes involved in offshore R&D but also serves well this study's focus on practice (Pettigrew, 1990). The empirical research involved developing detailed case studies and cross-case analysis aimed at identifying patterns of similarities and differences across cases (Eisenhardt, 1989b; Yin, 2003b).

1.7 RESEARCH RELEVANCE

Offshoring of R&D signifies a new international division of labor and shifting geographies of innovation. With growing propensity of offshoring of R&D, a systematic understanding of the phenomenon and its focal aspects assumes critical importance. Although offshoring of R&D has emerged as an integral component of the R&D globalization strategy of high technology firms (UNCTAD, 2005), literature that specifically and directly deals with the topic is non-existent. The business press frequently mentions innovation, speed, and flexibility to be the key benefits of offshoring of R&D besides, of course, efficiency that comes from low cost structures. Therefore, there is an immediate and acute need to systematically understand the phenomenon of offshoring of R&D and its association with firm innovative capability and organizational flexibility—the two most important organizational capabilities of high technology firm. This research is a step towards that direction.

This study represents perhaps the first systematic and in-depth scholarly research to develop a comprehensive understanding of offshoring of R&D, and make new contributions to both theory and managerial practice. Specifically, grounded in real-life instances of offshoring of R&D across high technology industry sectors, this study illuminates on the link between offshoring of R&D and a firm's innovative capability and organizational flexibility. In terms of its contributions, the research advances a process theory explaining the association between offshoring of R&D and firm innovative capability and organizational flexibility. The study makes a further contribution by comparing and contrasting the two modes of offshoring of R&D, namely intra-firm offshore R&D and inter-firm offshoring of R&D, especially focusing on innovative capability and organizational flexibility. In addition, based on extensive empirical research, a definition of 'offshore R&D' is also advanced with detailed characterization of the phenomenon. This hopefully will set the stage for further empirical work and academic discourse on the topic.

Furthermore, an outcome of the theorizing is a normative model of offshoring of R&D, which hopefully will inform managerial practice. The model provides guidance not only on how to effectively organize and manage offshoring of R&D for innovative capability and organizational flexibility but also how to harness the two modes of offshoring of R&D. Importantly, this research argues that offshoring of R&D is a new organizational form (Lewin and Volberda, 1999; Herber, *et. al.*, 2000), which is the result of the confluence of disaggregation and vertical disintegration of R&D value chain. Also, it may be noted that despite its considerable importance, prior research has not specifically examined the link between R&D globalization and organizational flexibility. This study makes an important contribution on this front. From a methodological point of view, this research is one of the few ideographic studies that deal with globalization of R&D. Indeed, the study represents perhaps the first interpretive research study aimed at exploring the terrain of a macro phenomenon like offshoring of R&D (Prasad and Prasad, 2002).

1.8 OVERVIEW AND ORGANIZATION OF THE THESIS

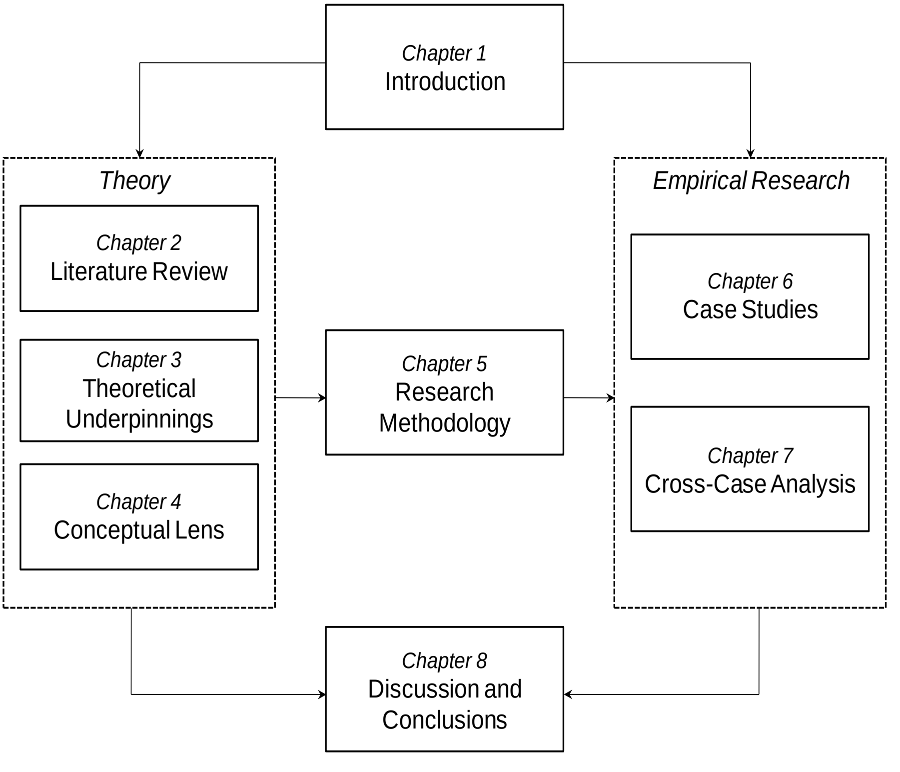


Figure 1.4: Organization and Overview of the Research

Figure 1.4 shows the organizing structure of the dissertation. Following this introductory chapter, Chapter 2 provides a review of the relevant R&D globalization literature. This includes the relevant literature on global R&D outsourcing, given that this concerns both intra-firm and inter-firm offshoring of R&D. Based on the insights derived and gaps surfaced from the literature review, Chapter 3 explicates the theoretical underpinnings for the study. Specifically, the concepts of innovative capability and organizational flexibility are elaborated in Chapter 3 in addition to reviewing the dynamic capabilities perspective and agency theory. Chapter 4 integrates insights and concepts from Chapters 2 and 3 to develop the conceptual lens for the empirical inquiry. Essentially, this chapter provides tentative theoretical enlightenment on the research questions. Chapter 5 presents the empirical research methodology in detail, explicating the research approach, the multiple case study design, the methods and procedures used for data collection and analysis. Issues of research quality and validity are also discussed in this chapter.

Following this, Chapter 6 contains the case studies that provided the empirical basis for this research. In Chapter 7, the findings from the cross-case analysis are presented and similarities and differences across cases are discussed. Analysis in Chapter 7 is confined to the focal aspects of the phenomenon under study. The conceptual lens described in Chapter 4 provides the organizing and analytical framework for Chapters 6 and 7. Finally, the last chapter (Chapter 8) synthesizes the findings of the research, provides answers to the research questions, and discusses the contributions and limitations of the research, and provides directions for future research. This chapter also presents a normative model linking offshoring of R&D with firm innovative capability and organizational flexibility aimed at providing guidance to managers.

CHAPTER 2
LITERATURE REVIEW

THE PREVIOUS CHAPTER discussed the phenomenon of offshoring of R&D and described the objectives of this research. Chapter 1 noted that while the business press has keenly followed the phenomenon and highlighted its many benefits (e.g., Dehoff and Sehgal, 2006; Duga and Stutt, 2006; Lewin and Peeters, 2006; Engardio, 2006b; Khurana, 2006), the academic literature on offshoring of R&D is yet to develop (Bardhan, 2006). Indeed, there is increasing recognition among scholars that offshoring of R&D is a new and significant phenomenon that needs to be systematically explored (McCann and Mudambi, 2005; Bardhan, 2006; Mudambi, 2007; Jensen and Pedersen, 2007). However, currently there are only a handful of preliminary studies that attempt to explore the terrain of offshoring of R&D (Bardhan, 2006; Jensen and Pedersen, 2007; Maskell, *et. al.*, 2007). As such, research examining the link between offshoring of R&D and firm innovative capability and organizational flexibility is nonexistent. As a result, prior research that can directly illuminate this inquiry is not available.

However, as mentioned in Chapter 1, offshoring of R&D can be interpreted as a part of the larger phenomenon of globalization of R&D (Jaffee, 2004), which has a vast and relatively well-developed literature. Even though offshoring of R&D differs from the traditional globalization of R&D in terms of its underlying motives (efficiency and knowledge resources versus markets and technology), there is resemblance between the two in terms of their characteristics. For example, both involve pursuit of R&D activities in a geographically distributed manner. Also, both signify a dyadic relationship between the parent firm and the global/offshore R&D unit. Therefore, the extant literature on R&D globalization, especially those strands that deal with organization and management aspects of global R&D, has the potential to inform this research. Therefore, the goal in this chapter is to review the R&D globalization literature to search for insights that can inform this inquiry. First, the limited and emerging literature on offshoring of R&D is reviewed. Next, the relevant strands of the R&D globalization literature are reviewed. The chapter also enfolds a brief review of the literature on R&D externalization, given the focus of this research includes inter-firm offshoring of R&D.

2.1 OFFSHORING OF R&D

Today's complex and interdisciplinary innovations require diverse R&D skills that can be accessed at lower cost structures through offshoring while simultaneously accelerating innovation speed (Bardhan, 2006). In an early attempt to understand the terrain of the phenomenon, Bardhan and Jaffee (2005) in a survey of high technology firms found that the impulse to innovate at the level of product and process was more important than the imperative to reduce costs through offshoring of R&D. Their survey findings indicated that for core R&D activities firms preferred to establish their own offshore R&D affiliates, whereas the more routine R&D activities were offshored to third-party R&D outsourcing service providers. The survey findings also revealed a relationship between firm size and propensity to offshore, suggesting a tendency among larger firms to establish their own offshore R&D affiliates. In another early study, Jensen and Pedersen (2007) discuss whether and what to offshore, and recommend adoption of the “core competence” and “strategic outsourcing” perspectives to aid the decision-making process. These authors assert that offshoring is a dynamic process that evolves over time. Notably, Jensen and Pedersen (2007) highlight the need for research on the new phenomenon of offshoring of R&D, especially the process related aspects. Another recent study of a cross-section of Danish firms points to the dynamic and evolutionary nature of the process of offshoring of R&D. The study finds that offshoring of R&D is a learning-by-doing process and evolves in its focus and scope, initially from the desire to achieve cost reduction to improve quality and innovation over a period of time (Maskell, *et. al.*, 2007).

Bardhan (2006) integrates concepts of nature (systemic versus autonomous) and type (incremental versus radical) of innovation, market (input versus output), skill specificity, and mode of offshoring (intra-firm versus inter-firm) and provides a macro level discussion of organization structure and management practices for effective offshoring of R&D. According to the author, a centralized structure is more appropriate for systemic innovation, whereas a decentralized set-up may be more compatible with autonomous innovation. Likewise, offshoring of R&D may not be appropriate for radical innovation that typically require closer coupling with the target markets and co-location of R&D teams. Moreover, offshoring of R&D may not be appropriate when skill specificity is high. Furthermore, offshoring of R&D can cater to a firm’s input market (factor endowment by way of R&D resources and knowledge) and output market through access to knowledge about the emerging markets in which firm’s offshore R&D set-up is embedded. Finally, the author contends that for R&D of proprietary and sensitive nature, intra-firm offshoring of R&D is more appropriate than inter-firm offshore R&D sourcing, which is typically suitable for routine R&D activities. The author argues that with the growth in offshoring of R&D, firms will increasingly adopt a cellular organizational form (C-form), organizing their R&D activities globally by locating different parts of R&D value chain in countries/regions that offer best leverageable advantage (Bardhan, 2006).

Summary: While several scholars recognize that offshoring of R&D is a new phenomenon of considerable economic significance and highlight the need for systematic research (e.g., Bardhan, 2006; Mudambi, 2007; Jensen and Pedersen, 2007), the literature on offshoring of R&D seems to be in its formative stages. As such, studies focusing on organizational and management processes, or examining the impact of offshoring of R&D on such strategic dimensions as innovative capability, organizational flexibility, or firm competitiveness are not readily apparent.

2.2 GLOBALIZATION OF R&D

Globalization of R&D is the process of distributing R&D activities globally with the objective to leverage technical resources and capabilities of each location to augment the firm's innovative capabilities (Chiesa, 1996). The roots of the literature on globalization of R&D can be traced back to Vernon's (1966, 1979) product life cycle theory that explained how firms could exploit product innovations developed in their home countries and maximize gains over the lifecycle of the product by locating R&D activities abroad to expand their markets and gain R&D efficiency (Nohria and Ghoshal, 1997; Cohen, 2007). However, the mid 1980s witnessed the emergence of a new trend characterized by technology-seeking motive among firms to leverage globally dispersed centers of technological excellence to boost their innovative capabilities through global R&D networks (Nohria and Ghoshal, 1997; Florida, 1997; Gerybadze and Reger, 1998, 1999; Niosi, 1999; Pearce, 1999; Cantwell and Janne, 1999; Cantwell and Narula, 2001). The trend towards organization of globally integrated R&D networks has only intensified over the years, questioning the continued relevance of Vernon's product life cycle theory (Cantwell, 1995; Cohen, 2007).

The literature on globalization of R&D is vast and can be classified into several streams (Cheng and Bolon, 1993; Birkinshaw, 2001, 2003). Table 2.1 identifies and briefly describes the various streams of the literature along with major representative works corresponding to each. It may be noted that the literature on globalization of R&D has largely developed in the context of research on multinational corporations (e.g., Bartlett and Ghoshal, 2002; Nohria and Ghoshal, 1997; Boutellier, *et. al.*, 2000; Cohen, 2007). As a result, often issues pertaining to globalization of R&D are interspersed with and subsumed in the larger discourses on management of multinational enterprises (e.g., Bartlett and Ghoshal, 2002; Nohria and Ghoshal, 1997). However, the scope of the review in section is confined only to those studies that directly deal with globalization of R&D or in which global R&D constitutes the major focus of inquiry. It is noteworthy that despite flexibility being central to the recent modeling of multinational enterprises, literature explicitly examining organizational flexibility in the context of R&D globalization is non-existent (Buckley and Casson, 1998; Allen and Pantzalis, 1996) except for Zander (1999).

Table 2.1: Major Streams of the Literature on Globalization of R&D

Stream	Description	Major Representative Works
Determinants of R&D Globalization and Location Decisions	The literature in this stream concerns factors that influence location decisions for global R&D operations. This stream also concerns mode of R&D globalization.	Ronstadt (1978); Florida (1997); Gerybadze and Reger (1998); Penner-Hahn (1998); Hakanson and Nobel (1993a); Gassmann and von Zedtwitz (1998); Voelker and Stead (1999); Le Bas and Sierra (2002)
Taxonomies of Global R&D Organizations	The literature in this stream presents taxonomies and typologies of different types of global R&D organizations.	Ronstadt (1978); Kuemmerle (1997); Zander (1999); Chiesa (1996, 2000, 2001); Gassmann and von Zedtwitz (1999); Medcof (1997)
Coordination and Control in Globalization of R&D	The literature in this stream focuses on the relationship between the firm headquarters and the global R&D unit, and considers issues of coordination and control of global R&D activities.	Fischer and Behrman (1979); Reger (1997, 1999, 2004); Martinez and Jarillo (1989, 1991); Kim *et. al.* (2003)
R&D Globalization and Innovation	The literature in this stream focuses on generation of innovation as well as knowledge creation, transfer, and integration in the context of R&D globalization.	Ghoshal and Bartlett (1988); Nohria and Ghoshal (1997); Nobel and Birkinshaw (1998); Persaud (2005); Almeida, *et. al.* (2002); Piscitello and Rabbiosi (2004); Venaik, *et. al.* (2005); Subramaniam and Venkatraman (2001); Foss and Pedersen (2002, 2004); Westney (2001); Gupta and Govindarajan (1991, 2000); Birkinshaw, *et. al.* (2002); Frost and Zhou (2005); Hansen and Lovas (2004); Kotabe, *et. al.* (2007); Singh (2008); Song and Shin (2008)

Table 2.1: Major Streams of the Literature on Globalization of R&D (…Continued)

Stream	Description	Major Representative Works
R&D Subsidiary Management	This stream concerns issues of management and performance of global R&D subsidiaries. The R&D subsidiary is the unit of analysis in this stream of literature.	Furu (2001); Frost, *et. al.* (2002); Cantwell and Mudambi (2005); Mudambi, *et. al.* (2007)
Macro-level/Cross-Sectional Studies on Globalization of R&D	The literature in this stream includes macro-level/cross-sectional studies aimed at uncovering patterns and trends in organization and management of global R&D.	De Meyer and Mizushima (1989); Ronstadt (1978); Hakanson and Nobel (1993a, 1993b); Pearce and Papanastassiou (1996); Florida (1997); Cantwell and Janne (1999); Meyer-Krahmer and Reger (1999); Cantwell *et. al.* (2004)

In what follows, the major taxonomies of global R&D organizations are reviewed followed by a review of the literature on coordination and control in R&D globalization. Next, the literature on R&D globalization and innovation is reviewed. This is followed by a brief review of the relevant literature on global R&D subsidiary management for that may provide some useful perspectives, given an offshore R&D unit is somewhat akin to a global R&D subsidiary. However, since this research does not concern with determinants and location decisions for offshoring of R&D, that literature stream is not included in the scope of this review. Similarly, the macro-level and cross-sectional studies on globalization of R&D are not reviewed here for they do not specifically relate with the focal aspects of this study.

2.2.1 Taxonomies of Global R&D Organizations

Several scholars have advanced taxonomies for global R&D organizations based on empirical studies. For example, in an early study of R&D investments made abroad by seven U.S.-based multinational firms, Ronstadt (1978) found four types of global R&D units: (1) Technology Transfer Units, (2) Indigenous Technology Units, (3) Global Technology Units, and (4) Corporate Technology Units. The technology transfer units were responsible for transferring technology from firm headquarters in the U.S. to the overseas subsidiary and also provided technical services to local customers. The indigenous technology units were chartered with development of new or improved products for the local markets. The global technology units engaged in development of new products or processes for the global markets and were often assigned full responsibility for one or more product lines. Finally, the corporate technology units were established to pursue long-term R&D with a view to develop new technologies and processes for the parent firm.

Similarly, based on a study of 150 foreign R&D sites of Sweden's top 20 manufacturing multinationals, Hakanson and Nobel (1993) proposed an empirically derived typology of global R&D sites. The authors found that the market-oriented foreign R&D units were established for reasons of proximity to market and performed adaptive R&D activities for the local market. However, over a period of time such R&D units evolved to perform higher levels of R&D tasks. The foreign research units were established to primarily tap into overseas technological infrastructure, whereas the production support units were established to provide support for local production activities. The study also found foreign R&D units that were established with multiple motives as well as those that were politically motivated.

The study of foreign direct investments in R&D by 32 large pharmaceutical and electronics multinationals by Kuemmerle (1997, 1999) suggested that that there are primarily two types of global R&D sites: (a) home base exploiting and (b) home base augmenting. Home base exploiting sites are established to exploit innovations produced by a firm in its home country on a global scale, whereas home base augmenting sites are established to enhance a firm's innovative capability by leveraging foreign centers of R&D excellence. Similarly, in their study of R&D globalization Archibugi and Michie (1995) found that primarily two types of global R&D organizations existed: one that catered to global exploitation of innovations first produced by a firm in its home country and the other that aimed to leverage foreign centers of R&D excellence in order to enhance the firm's innovative capability (Archibugi and Michie, 1995).

Based on a cluster analysis of patent data of 24 major Swedish multinationals and differentiating between international duplication and international diversification of technological capabilities, Zander (1999) proposed four types of R&D organizations: home centered, internationally duplicated, internationally diversified, and dispersed (duplicated as well as unique capabilities). In Zander's (1999) taxonomy, home centered R&D sites are located in the firm's country of origin and house majority of the firm's technological capabilities. Internationally duplicated R&D sites are geographically dispersed and possess technological capabilities that overlap with those available at the firm's headquarters or other global R&D sites of the firm. On the other hand, internationally diversified R&D units are also geographically dispersed but possess unique technological capabilities. Finally, the dispersed R&D sites are those that possess a combination of duplicated and unique technological capabilities. Zander (1999) argues that the internationally duplicated R&D sites offer the flexibility of being able to shift the focus of R&D activities within the multinational network and also foster cross-fertilization of exchange of knowledge.

Medcof (1997) advanced a taxonomy of internationally dispersed technology units based on a three dimensional classification system: type of technical work (research, development, or technical support), functional areas with which the technical units collaborate (marketing, manufacturing, etc.), and geographic area of collaboration (local, global). Medcof suggests that there are four distinct types of foreign R&D labs: international research unit, international development unit, international market support unit, and international manufacturing support unit. An international research unit develops new technical knowledge in collaboration with at least another technology unit located outside of its host country. An international development unit creates new products and processes in collaboration with marketing and manufacturing units, and also perhaps with another technology unit, at least one of which is located outside of its host country. An international marketing support unit carries our adaptations of already established products in collaboration with marketing or another technology unit, at least one of which is located outside its host country. Finally, an international manufacturing unit adapts manufacturing processes to a desired condition in collaboration either with manufacturing or another technology unit, at least one of which is located outside its host country.

Another field study of 12 technology-intensive multinational companies from different countries revealed the existence of four different types of global R&D organizations: research labs, development labs, adaptive R&D units, and technology scanning units (Chiesa, 1996, 2000, 2001). The first three are similar to the international research unit, international development unit, and international market support unit, respectively, in Medcof's (1997) classification above, whereas technology scanning units refer to R&D outposts located in foreign centers of technological excellence that feed technical intelligence to the firm's central/global R&D labs. Considering degree of dispersion of firm's R&D resources and degree of dispersion of external sources of knowledge, Chiesa's study (2001) also suggested two distinct structures for global R&D: specialization-based structure and integration-based structure. In a specialization-based structure, global R&D labs have worldwide mandate for developing a new technology, product or process. A specialization-based structure allows for improved coordination through concentration of resources at one location and promotes R&D efficiency as well as economies of scale. Centers of excellence are examples of specialization-based structure. In an integration-based structure, different globally dispersed units contribute to R&D programs with a view to jointly create global innovations. An integration-based structure is characterized by centralized coordination.

Globalization of R&D

Drawing on a study of 33 technology-based U.S., European and Japanese companies, and considering degrees of cooperation between the units and the dispersion of R&D activities, Gassmann and von Zedtwitz (1999) identified five different types of global R&D organizations: ethnocentric centralized, geocentric centralized, polycentric decentralized, R&D hub, and integrated R&D networks. Ethnocentric centralized R&D organizations are centralized R&D organizations with national inward orientation and homogenous culture. They offer high R&D efficiency due to scale effects and better protection for firms' core technologies. However, they lack sensitivity to local marker needs and run the risk of missing on important external technologies. Geocentric centralized R&D organizations are characterized by centralized R&D and international cooperation. They are also efficient due to centralization of R&D activities at home and yet highly sensitive to local markets and external technologies, but they lack the benefit of systematic globalization. Polycentric decentralized organizations are highly dispersed R&D units with a weak center that favor local effectiveness over global efficiency. They demonstrate strong sensitivity to local markets but promote inefficiency and duplication. R&D Hubs are organizational structures that involve globally dispersed but centrally coordinated R&D units. Due to centralized coordination, R&D hubs are highly efficient (because they eliminate redundancy) and facilitate realization of synergies. However, they involve high costs of coordination and run the risk of suppressing creativity. Finally, integrated R&D networks involve highly dispersed global R&D units designed to achieve synergetic integration. They are characterized by collaboration among global R&D units having specialized competencies and global responsibilities for technologies or products. Integrated R&D networks offer the benefits of specialization and synergy but require complex coordination at high costs.

Finally, Boghani, *et. al.* (1998) have proposed a typology of global R&D organizations based on two dimensions: (a) market versus technology focus and (b) degree of centralization. They identify five different types of global R&D organizations, characteristics of which are intuitively obvious: (1) Single, Central R&D Center, (2) Network of Regionally Focused R&D Centers Supported by Centers of Excellence, (3) Network of Technology Focused Centers of Excellence with Global Coordination, (4) Network of Fully Autonomous, Regionally Focused Centers and (5) Network of Fully Autonomous, Technology-Focused Centers of Excellence. In the type 3 organization (Network of Technology Focused Centers of Excellence), each center contributes specialized competence towards creation of a global innovation that is centrally coordinated. However, in the type 5 organizations (Network of Fully Autonomous, Technology-Focused Centers of Excellence) each unit in the network is a full-fledged center of excellence in a certain technology domain and has worldwide responsibility for a product or product line.

Summary: Taxonomies of global R&D organizations have been developed based either on the purpose of the global R&D units and the nature of their R&D activities, or based on the type of organization structure. Commensurate with the conceptualization of multinational organizations as inter-organizational network (Ghoshal and Bartlett, 1990), recent taxonomies of global R&D organizations also adopt a network perspective (i.e., global R&D network). However, while the existing typologies shed light on the role and management of technology-oriented global R&D units, they do not specifically illuminate on the role and characteristics of offshore R&D organizations. Both the technology focused global R&D unit and an offshore R&D organization support firm's technological capabilities. However, the primary motivation in establishing a technology focused global R&D unit is to tap overseas centers of technological excellence, whereas considerations of improved efficiency and access to technical resources drive formation of offshore R&D organizations. Conceivably, then, different organizational and managerial considerations are implied for offshore R&D units. Nevertheless, based on the discussion in Chapter 1, an offshore R&D organization may be seen as a home-base augmenting R&D organization (Kuemmerle, 1997) that operates in an integration-based structure (Chiesa, 2000). An offshore R&D unit could be a center of excellence in certain technology or competence areas. An offshore R&D organization may also be viewed as a node in a global R&D network with other global R&D units bestowed with different charters.

2.2.2 Coordination and Control in Globalization of R&D

The main focus of this stream is on headquarters-subsidiary relationships, and the associated control and coordination mechanisms employed for management of globally dispersed R&D activities. Most of the literature in this research stream concerns choice and application of appropriate control and coordination mechanisms for governance of subsidiaries for improving the overall performance of the multinational firm (Doz and Prahalad, 1984). Control is a process which brings about adherence to a goal through regulation of activities and exercise of authority (Child, 1973), whereas coordination is an enabling process which provides integration among different task units within the firm (Cray, 1984; Martinez and Jarillo, 1989). The coordination and control of a subsidiary are contingent upon subsidiary's strategic context, which includes subsidiary mandate/role, type and level of resources possessed by the subsidiary, and the subsidiary's local environment (Martinez and Jarillo, 1991; Gupta and Govindarajan, 1991; Nohria and Ghoshal, 1994).

Scholars have viewed headquarters-subsidiary relations as similar to principal-agent relationship (Doz and Prahalad, 1991; Nohria and Ghoshal, 1994; Gupta and Govindarajan, 1991; Jensen and Meckling, 1976). A branch of agency theory (Jensen and Meckling, 1976; Eisenhardt, 1989a), the principal-agent relationship perspective provides a useful framework for analyzing issues of control in headquarters-subsidiary relationship in 'outcome' or 'behavioral' terms (Doz and Prahalad, 1991; Eisenhardt, 1989a). When the behavior of a subsidiary cannot be easily monitored or when there is likelihood of goal incongruence between the headquarters and subsidiary, defining outcomes to be contributed by the subsidiary may offer an effective approach to control. On the other hand, in case of highly interdependent, globally integrated subsidiaries, where the substantive understanding of the task to be performed resides at the headquarters, a behavior-based approach to control may be more appropriate. The principal-agent relationship implies a hierarchical relationship structure with centrality of headquarters (Doz and Prahalad, 1991; Nohria and Ghoshal, 1994).

Baliga and Jaeger (1984) identify two types of control in the context of multinational enterprises: bureaucratic control and cultural control. The bureaucratic mode of control utilizes well-defined sets of rules, regulations, and procedures that establish the boundary of subsidiary's role, responsibility, and authority. The cultural control mode, on the other hand, relies on socialization as well as placement of a number of trustworthy managers from the headquarters at the subsidiary to supervise subsidiary functioning. Geographical dispersion limits the ability of the headquarters managers to exercise control over subsidiaries. Managers at the headquarters may also have the quest for power. Therefore, headquarters may show a propensity to establish bureaucratic modes of control. Cultural control underlies reinforcement of processes for development of trust and cultural alignment. Cultural control mode is inappropriate in organizational settings that are characterized by high mobility and turnover of people. Usually, both modes of control co-exist in different degrees in the context of headquarters-subsidiary relationship in a multinational enterprise (Baliga and Jaeger, 1984).

Coordination mechanisms are administrative tools used for the process of coordination and help achieve integration among different task units (Martinez and Jarillo, 1989; Reger, 1997, 1999). A review of the literature suggests that multinational corporations employ two classes of coordination mechanisms: formal and informal (Martinez and Jarillo's, 1989, 1991; Reger, 1997, 1999). Formal mechanisms include centralization, formalization, planning, and output and behavioral control (Martinez and Jarillo's, 1989, 1991; Reger, 2004). Centralization refers to the extent to which decision-making is centralized through the hierarchy of formal authority (Lawrence and Lorsch, 1967; Galbraith, 1973). Formalization refers to the extent of reliance on written policies, job descriptions, procedures, standards, and instruction manuals for performance of tasks, leading to *standard* organizational routines (Lawrence and Lorsch, 1967; Galbraith, 1973). Planning refers to processes such as strategic planning, R&D portfolio, budgeting, scheduling, goal-setting, etc. that guide actions of the organizational actors and channel their efforts (Galbraith, 1973). Finally, output control refers to control of technical and financial performance, whereas behavioral control involves supervision of behavior of subordinates (Eisenhardt, 1989a).

Informal mechanisms include lateral relations, informal communication, and socialization (Martinez and Jarillo's, 1989, 1991; Reger, 1997, 1999). Lateral relations go beyond the hierarchical structure and involve direct contact among members of different departments that share a common objective or task, and include temporary structures like task forces and committees (Lawrence and Lorsch, 1967; Galbraith, 1973). Informal communication refers to creation of a network of informal and personal contacts among organizational members from across different groups of the company. Corporate meetings, conferences, visits, transfer of managers, etc. promote informal communication networks. However, unlike lateral relations, informal communication is not structured around a specific task or objective (Martinez and Jarillo, 1989, 1991). Finally, socialization refers to the development of an organizational culture with shared values and norms (Edstrom and Galbraith, 1977; Gupta and Govindarajan, 2000).

Fischer and Behrman (1979) studied 35 American and 18 European multinational companies to understand coordination practices for their foreign R&D activities. The authors found that the choice of coordination practices not only affects the patterns of innovative outcomes at the foreign R&D sites but also the volume and nature of foreign R&D activities. Even though considerable autonomy is required for creative pursuit of R&D activities, some control needs to be exercised to ensure alignment of R&D activities with the overall corporate interests and priorities. Fischer and Behrman's (1979) study revealed four distinct coordination practices adopted by multinational firms on the centralization-autonomy continuum: Absolute Centralization, Participative Centralization, Supervised Freedom, and Total Freedom. When absolute centralization is used, the parent controls the R&D commitment and resource requirements at the foreign R&D affiliate, whereas in the case of participative centralization the R&D agenda and funding requirements for the foreign affiliate are jointly determined between the two parties. On the other hand, when supervised freedom is employed, the foreign R&D affiliate has the authority to establish its program commitment but the parent firm may provide guidance, whereas in the case of total freedom the foreign affiliate has the full authority to define its R&D agenda.

The study by Fischer and Behrman (1979) showed that when the degree of centralization is higher, there is a greater reliance on structured control over funding, R&D programs and project selection decisions. Moreover, higher degree of centralization was associated with higher volume of foreign R&D activity, although with less proportion of new product R&D. The findings also revealed the impact of coordination styles on the patterns of innovation among foreign R&D activities of the firm. On one hand, the bureaucratic procedures involved with higher degree of centralization caused delays in the decision and review processes of R&D projects and introduced rigidity, on the other hand centralization allowed more efficient deployment of total corporate R&D resources by eliminating potential duplications. The authors suggested that tightly coordinated R&D practices are more appropriate for international R&D activities for they enable efficient resource allocation.

Kim *et. al.* (2003) posit that for global R&D integration, people-based and information-based coordination modes are more effective than centralization or formalization based modes. They define people-based coordination as involving lateral relations, informal communication, and socialization. People-based coordination mode facilitates development of mutual understanding and trust, promotes inter-personal communications and knowledge sharing (De Meyer, 1991). Information-based coordination, on the other hand, involves flow of information through databases, electronic mail and the Internet, and uses information systems (Galbraith, 1973). R&D requires extensive information sharing and communication across units to promote global learning (De Meyer, 1991). Information-based coordination satisfies the need for information exchange across borders at low costs and quickly. Kim, *et. al.* (2003) argue that since R&D activities are unstructured and tacit in nature, formalization may not be an effective mechanism for coordination of R&D activities.

The choice of the appropriate coordination mechanisms for a particular headquarters-subsidiary relationship context depends on the role that is assigned to the subsidiary and the level of coordination required (Martinez and Jarillo, 1991; Gupta and Govindarajan, 1991; Nohria and Ghoshal, 1994). In an empirical study of 50 subsidiaries of multinational firms in Spain, Martinez and Jarillo (1991) found that as the need for integration of the subsidiary with the headquarters and other units within the multinational increases, the reliance on formal and informal coordination mechanisms also proportionately increases. In addition, they also found that the informal mechanisms play an instrumental role and complement the formal ones. Similarly, Gupta and Govindarajan's (1991) study of 359 foreign subsidiaries of U.S., Japanese and European multinational firms reinforces the need to match the control and coordination mechanisms to the specific strategic context of the subsidiary.

Based on an empirical study of 18 large Japanese and European multinational companies, Reger (1999, 2004) provides a framework for determination of appropriate coordination mechanisms for management of global R&D. The author suggests that when the possibility of structuring a task is high, the degree of uncertainty and novelty associated with the R&D project is low and when the knowledge is codified, formal mechanisms are more appropriate. Also, when the cultural distance between the headquarters and the foreign R&D site is high, informal coordination mechanisms are less appropriate since they are based on shared values, norms and behaviors. Considering variations in knowledge flow patterns, Gupta and Govindarajan (1991) suggest that the aspects of control and coordination may be analyzed based on whether the subsidiary is primarily a recipient of knowledge inflows from the rest of the corporation or instrumental in knowledge outflows to the rest of the corporation.

Empirical studies suggest that the headquarters-subsidiary relationship evolves over a period of time along with the evolution in subsidiary's role (Hedlund, 1984; Asakawa, 2001). Several empirical studies also indicate a pattern of evolution from exclusive reliance on formal coordination mechanisms to an increasing preference for informal mechanisms among multinational firms (Martinez and Jarillo, 1989, 1991; Reger, 1999; Kim, *et. al.*, 2003). In the literature multinational management, the headquarters-subsidiary relationship has also been viewed from the perspective of procedural justice theory (Taggart, 1997; Kim and Mauborgne, 1991, 1998). The procedural justice concept concerns the extent to which the dynamics of the multinational's strategy making process for its subsidiaries are judged to be fair by the subsidiaries (Kim and Mauborgne, 1991, 1993).

Summary: Most of the extant literature on control and coordination deals with the broader context of the headquarter-subsidiary relationship in multinational corporations. The literature that specifically focuses on aspects related to control and coordination in globalization of R&D is limited (e.g., Reger, 1997, 1999, 2004; Kim, *et. al.*, 2003). Moreover, the literature that specifically analyses efficacy of various control and coordination mechanisms for different types of global R&D organizations is rather sparse. As such, the control and coordination issues pertaining to offshoring of R&D have not been discussed. However, the extant literature offers some guidance for determination of coordination mechanisms for a global R&D organization based on its particular type as well as the nature of its R&D contribution.

2.2.3 R&D Globalization and Firm Innovative Capability

Multinational firms are essentially social communities and their ability to create, transfer, and recombine knowledge determines their innovative capability (Kogut and Zander, 1993). A multinational firm's innovative capability depends on its ability to generate innovative contributions by leveraging the knowledge and capabilities available throughout its globally distributed organizational units. Studies indicate that there are various organizational attributes that influence a multinational firm's innovative capability. These include knowledge assets (Kogut and Zander, 1992; Bartlett and Ghoshal, 2002) and slack resources (Cyert and March, 1991; Bartlett and Ghoshal, 2002), structural characteristics of the headquarters-subsidiary relationship (Burns and Stalker, 1991; Lawrence and Lorsch, 1967; Bartlett and Ghoshal, 2002), socialization processes (Bartlett and Ghoshal, 2002; Gupta and Govindarajan, 2000), and the patterns of communication among the organizational units (Allen, 1977; Nohria and Ghoshal, 1997; Bartlett and Ghoshal, 2002).

Two fundamental challenges involved in globalization of R&D are: (a) finding the optimal balance between centralization (to achieve efficiency and avoid duplication) and autonomy and (b) optimizing knowledge flows among globally distributed R&D units to improve learning (De Meyer and Mizushima, 1989). Empirical studies on innovative capability in the context of globalization of R&D have developed in two different but related streams. The first stream concerns impact of organizational design on innovative capability, whereas the second one deals with transfer of knowledge among the globally distributed organizational units. Knowledge transfer is considered to be a source of a multinational firm's ability to develop, share and leverage knowledge (Bartlett and Ghoshal, 2002; Gupta and Govindarajan, 1991). Knowledge transfer among geographically dispersed organizational units promote inter-unit cooperation and mutual learning that stimulate new knowledge creation and, at the same time, enhance the ability of organizational units to innovate (Tsai, 2001; Kogut and Zander, 1992; Bartlett and Ghoshal, 2002). This section reviews major studies in both the streams that closely relate to the focus of this inquiry.

Ghoshal and Bartlett (1988) carried out a multi-phased study to understand organizational attributes that facilitate creation, adoption, and diffusion of innovations by subsidiaries of multinational companies. The study employed case studies and surveys spanning 66 North American and European multinational companies. Innovation creation by subsidiaries concerned development of new products, processes and administrative systems using their own technical and managerial resources.[1] The study revealed four organizational attributes of a subsidiary that influenced its ability to creation innovations: (1) decision-making autonomy, (2) availability of slack resources, (3) normative integration of the subsidiary (achieved through socialization) with the goals and values of the parent company, and (4) the densities of communication (a) among managers within the subsidiary and (b) between managers in the headquarters and the subsidiary. This study, however, did not consider situations in which global innovations were jointly created by the headquarters and subsidiaries.

Nobel and Birkinshaw (1998) attended to issues of global innovation in multinational corporations by examining patterns of control and communication in global R&D operations. Specifically, the authors studied aspects of control and coordination for three types of global R&D units—local adaptor (provides R&D support for local market adaptation), international adaptor (supports both local as well as international adaptation requirements), and international creator (performs R&D activities for the

[1] Given the focus of this dissertation, only innovation creation is of interest. Therefore, aspects related to innovation adoption or innovation diffusion are not included in this literature review.

global markets). The study was based on a survey of 110 global R&D units from 15 multinational corporations. The findings showed that: (a) multinational firms employed different modes of control to manage different types of global R&D units and (b) patterns of communication varied across the types of global R&D units. Local adaptors were managed with a high degree of formalization, whereas centralization was the predominant control mode for international adaptors coupled with moderate formalization. For international creators, high socialization and moderate centralization were the primary control modes. Local adaptors communicated mainly with local marketing units, local manufacturing units, and local customers. The international adaptors showed a more international communication profile; they interacted with corporate entities in other locations but not with external parties. Finally, international creators were found to have strong internal as well as external networks of communication.

Persaud, *et. al.* (2002) conducted an empirical study to evaluate the extent to which different coordination and control mechanisms, namely autonomy, formalization, socialization and communication, influenced the innovative capabilities of multinational firms. The study was based on a survey of R&D executives from 79 R&D facilities of 27 North American, Japanese and European multinational corporations from across industry sectors. In the study, innovative capability was defined as the ability to create new knowledge or to combine existing knowledge to create new products, processes, and technologies by efficiently and effectively exploiting the unique capabilities of global R&D labs. The construct of innovative capability was measured by ascertaining reduction in product development interval and cost, efficiency of resource utilization, and access to and transfer of complementary knowledge that materialized due to interdependence among the global R&D labs. The results from the multivariate regression and factor analysis suggested that the degree of autonomy of global R&D labs, the extent of socialization, and the effectiveness of in-person communication between the headquarters and the R&D labs at the subsidiaries positively influenced the innovative capability of multinational firms. Moreover, the findings of the study showed that autonomy, in-person communication and socialization had a mutually reinforcing effect on each other. The study also found formalization to positively influence efficiency of resource utilization but negatively impact innovation creation. In a related study, Persaud (2005) reported similar results.

Based on a survey questionnaire of top 500 German companies, Brockhoff and Medcof (2007) asserted that it is the quality of communication, and not quantity (frequency), that influences performance in global R&D. Drawing on case studies of global product innovation projects at a large European multinational firm, Berggren (2004) argued that R&D teams for radical innovation projects must be co-located because they require frequent interactions and adjustments, whereas incremental innovation projects are better suited for global R&D. Ariffin and Figueiredo (2004) investigated internationalization of innovative capabilities by studying Malaysian and Brazilian affiliates of multinational firms in electronics industry. The findings indicate varying degrees of innovative capability upgradation at the subsidiaries commensurate with their degree of autonomy and concentration of R&D activities.

Birkinshaw, *et. al.* (2002) investigated the validity of knowledge as a contingency variable and illuminated on issues of organization structure based on characteristics of knowledge. The authors considered two dimensions of knowledge: observability and system embededdness, and analyzed their influence on the level of unit autonomy and inter-unit integration in global network of R&D units. By observability, the authors meant the ease with which an activity can be understood by looking at and examining different aspects of the process or final product. System embeddedness refers to the extent to which the knowledge in question is a function of the system or context in which it is embedded. The empirical study was based on 50 interviews and questionnaire responses from 110 R&D unit managers at 15 Swedish multinational firms. The results showed strong association between the dimensions of knowledge and organization structure. The findings revealed that system embeddedness of knowledge is orthogonal to observability, and is a stronger predictor of organization structure. The authors concluded that (a) the more system embedded the knowledge is, the greater the autonomy of the R&D units and the less inter-unit integration between R&D units and (b) the more observable the knowledge, the less inter-unit integration between R&D sites.

Drawing on 14 case studies, De Meyer (1993a) asserted that management of global R&D must stimulate technical learning and highlighted five levers for catalyzing technical learning in multinational corporations: (1) creating and preserving diversity in geographically distributed R&D units, (2) promoting formal and informal communication, (3) enhancing the knowledge credibility of globally distributed R&D units, (4) using planning as a learning process, and (5) creation of internal and external organizational networks. The author observed that meaningful resource and task allocation influence the ability of global R&D units to contribute technical learning. Based on the same set of case studies, in another article, De Meyer (1991) that carefully designed organizational structures, boundary spanning individuals, rules and procedures, socialization, and communication technology can help improve communication and aid the process of learning. Use of information technology infrastructure has been found to be prevalent in management of global R&D, both for coordination and control and for facilitating knowledge flow and dissemination (e.g., De Meyer, 1993a; Teigland, *et. al.*, 2000; Westney, 2001).

Coordination of knowledge flows among globally distributed R&D units underpins the ability of a multinational firm to transfer and integrate knowledge. However, Howells (2000) argues that knowledge per se cannot be said to 'flow'. It is through flow of information and mutual learning experiences that knowledge is exchanged and absorbed within the cognitive structure of the firm, resulting in knowledge transfer. According to Howells (2000), knowledge transfer can either occur through embodiment in tangible assets or articulated formal and codified forms, or through informal, tacit channels (Howells, 2000). Geographical distance affects the likelihood, volume and effectiveness of knowledge transfer, especially the tacit knowledge. The embodied and codified knowledge can be accessed remotely and transferred easily, whereas exchange of tacit knowledge is contingent upon close and continuous interaction among organizational actors. Organizational structure influences the level of interaction and flow of knowledge among geographically dispersed R&D units (Howells, 2000).

Westney (2001) advanced conceptual thinking for analyzing processes for cross-border knowledge creation in globalization of R&D by considering the nature of knowledge and location of knowledge creation. The author distinguished between generic knowledge and context- and location-specific knowledge, and argued that the latter is difficult to move. The author highlights two types of global knowledge creation processes: one that combines generic knowledge of the centralized R&D labs with local subsidiary knowledge to produce locally tailored products, and another in which generic and complementary knowledge from several locations is combined to create global products.

Buckley and Carter (2004) focused on processes that multinational firms use for value creation by combining spatially dispersed knowledge. The authors highlight that knowledge flow and combination in multinational firms are impacted by spatial distance, time zone differences, and also differences in languages and cultures. In addition, tacitness and stickiness (i.e., contextual embeddedness of knowledge) affect transfer of knowledge. The authors posit that distance lowers levels of mutual awareness so that groups that are 'out of sight' can also remain 'out of mind'. Moreover, knowledge boundaries that result from differences in individuals' cognitive knowledge, as well as differences of language, social norms and identities, impact knowledge transfer. The authors argue that transfer of knowledge occurs easily and at low costs when the degree of shared knowledge, as well as language and other norms, is high among individuals. Knowledge transfer can occur by means of personal communication (talking, meeting, email, etc.), codified communication (reports, drawing, etc.), and embodied transfer (e.g., products, components, etc.).

Gupta and Govindarajan (2000) addressed issues of intra-firm knowledge transfer within multinational corporations with a focus on subsidiaries. Their study was based on data from 374 subsidiaries within 75 U.S., European and Japanese multinational companies. The study focused on the transfer of procedural knowledge (i.e., know-how) as opposed to declarative knowledge (i.e., know-what), and considered knowledge inflows and outflows from between peer subsidiaries parent organization. The authors conceptualized knowledge flows to be a function of (a) value of source unit's knowledge stock, (b) motivational disposition of the source unit, (c) existence and richness of transmission channels, i.e., formal and informal organizational integration mechanisms, (d) motivational disposition of the target unit, and (e) absorptive capacity of the target unit. The study showed that (1) knowledge outflow from a subsidiary was positively associated with the value of the subsidiary's knowledge stock and the richness of transmission channels and (b) knowledge inflow into a subsidiary was positively associated with richness of transmission channels, motivational disposition to acquire knowledge, and the capacity to absorb knowledge. The motivational disposition of the source unit did not show any significant impact on knowledge outflows.

Teigland, *et. al.* (2000) studied knowledge dissemination patterns in global R&D operations of multinational companies in the high technology electronics industry. Their studied focused on understanding mechanisms companies used to facilitate knowledge flow in global R&D networks, and was based on case studies. The authors found that in most of the cases the predominant focus was on implementing mechanisms that facilitated flow of knowledge for management and coordination of globally dispersed R&D activities. The studied revealed that the case study companies paid relatively little attention to flow of technical knowledge for problem solving. The study showed that all the case study companies had well-developed IT systems for facilitating knowledge flow for global coordination of R&D activities (for example, for project reviews). The study also found that although electronic repositories of knowledge and communication facilitators existed, they were not widely used for effecting flow of technical knowledge. The study showed that most companies used best-practices transfer, process documentation, use of cross-disciplinary teams, and rotation of R&D to varying degrees to facilitate transfer of technical knowledge. The cases also revealed several impediments to knowledge flow—people did not want to spend their valuable time in contributing to activities aimed at knowledge transfer, the target recipients of knowledge displayed 'not invented here' syndrome, and feeling of supremacy with possession of knowledge. The study concluded that the best way to facilitate knowledge transfer in global R&D networks was to create a culture for knowledge sharing and explicitly recognize knowledge transfer as a performance objective for individuals.

Subramaniam and Venkatraman (2001) examined 90 global product innovations in 52 American, Japanese and European firms to understand the processes and routines multinational firms employ for global product development. The findings of the study revealed that the ability to integrate and deploy geographically dispersed tacit knowledge significantly impacted the global product development capabilities of multinational firms. Specifically, the study showed that to create successful global product innovations, multinational firms either assemble cross-border teams involving members from overseas subsidiaries or communicate frequently with managers of overseas subsidiaries in order to obtain tacit knowledge about different product design requirements.

Linking theories of social capital and multinational corporations, Kostova and Roth (2003) argue that existence of social capital in the headquarters-subsidiary dyadic relationship significantly improves coordination and organizational integration. The authors suggest that multinational firms should cultivate social capital as both private (for use and benefit by individual organizational actors) and public (at an organizational level) good. The authors argue that the required level and forms of social capital are determined by the nature and degree of interdependence between headquarters and subsidiaries.

Hansen and Lovas (2004) carried out an exploratory study to understand the relationship among four factors generally considered to affect intra-firm transfer of knowledge in multinational corporations: formal organizational structure, informal relations, geographical distance, and relatedness of knowledge across globally dispersed organizational units. The study was based on a data set consisting of 4840 dyads between new product development teams and subsidiaries that were potential targets for transfer of knowledge. The findings of the study indicated that the four determinants interact with each other to affect the patterns of knowledge transfer. The findings also reveal several dynamics associated with transfer of knowledge in a multinational firm. For example, the authors found that teams prefer to approach people they are familiar with rather than people who have expertise in related technologies. Moreover, teams usually steered away from spatially distant subsidiaries that possessed related knowledge. However, the study found that established informal relations counteracted the effects of spatial distances and served as potent integrative mechanisms. Based on the findings, the authors assert the need to adopt an integrative framework to examine issues of knowledge transfer in multinational firms.

Instead of considering the characteristics of knowledge as determinants of knowledge transfer, Foss and Pedersen (2002) focused on levels and sources of subsidiary knowledge and aspects of organizational structure to study knowledge transfer in multinational corporations. Specifically, the authors highlighted the extent, type and management of interdependence among geographically dispersed units as an organizational design task that has implications for knowledge transfer. The authors asserted that generally high degree of interdependence between the transferring unit and receiving unit has a positive influence on knowledge transfer.

Bjorkman, *et. al.* (2004) investigated the influence of organizational control mechanisms on intra-organizational knowledge flows in multinational corporations. Incorporating socialization and agency theoretic perspectives, the study surveyed 134 Finnish and Chinese multinational corporations. The findings revealed that specifying the role of the subsidiary, explicitly identifying knowledge transfer as a performance evaluation criterion, and utilizing corporate socialization mechanisms greatly influenced transfer of knowledge among geographically dispersed subsidiary units. However, the study did not find any correlation between management incentives and use of expatriate managers with the extent of knowledge transfer.

Employing the knowledge-based view, Almeida, *et. al.* (2002) analyzed patent citations by semiconductor companies to evaluate whether intra-firm or inter-firm organization of global R&D was more effective as far as cross-border flow of knowledge was concerned. Their study revealed the crucial importance of intertwining of codified and tacit knowledge for innovative performance of firms, and highlighted the need for co-existence of formal and informal mechanisms for development of valuable knowledge. The findings of the study suggested that organization of global R&D on an intra-firm basis offers superior capability for deploying multiple mechanisms for knowledge transfer and integration.

Almeida and Phene (2004) examined the influence of external knowledge on innovation in subsidiaries of multinational firms. According to the authors, subsidiaries are simultaneously embedded in two knowledge contexts: the internal multinational network and the external environment of their respective host country firms. The authors argued that the extent of influences of these contexts on subsidiary technological innovation depends on the characteristics of the knowledge networks (technological richness and diversity) and the knowledge linkages of the subsidiary with other entities. Based on patent citation data pertaining to innovations by foreign subsidiaries of U.S. semiconductor firms, the authors found that the technological richness of the multinational, the subsidiary's knowledge linkages to the host country firms, and the technological diversity within the host country positively impact the innovative capability of the MNC subsidiaries.

Piscitello and Rabbiosi (2004) examined the ability of multinational firms to generate innovations based on resources and stimuli resident in their global R&D sites. The study considered knowledge transfer to be a key source of multinational firms' innovative capability, and was based on case studies of three Italian multinational firms. The study specifically aimed to understand the mechanisms the multinational firms used to facilitate absorption and deployment of knowledge from their geographically distributed subsidiaries. The results of the study indicated that a set of both formal and informal mechanisms facilitated knowledge transfer from subsidiaries to the parent organizations. Among the formal mechanisms, subsidiary's organizational autonomy and formalization of procedures played an instrumental role in facilitating knowledge transfer from subsidiaries to the parent organizations. The formal mechanisms enabled knowledge transfer through embodiment in products, patents and documents. Among the informal mechanisms, frequent exchange of visitors, task forces, and job rotation programs were significant in enabling knowledge transfer. The informal mechanisms facilitated exchange of tacit knowledge. The findings showed that the combination of formal and informal mechanisms allowed subsequent development of incremental as well as radical innovations.

Frost and Zhou (2005) studied reverse knowledge transfer, i.e., transfer of knowledge from subsidiaries to the headquarters of multinational firms by focusing on 'R&D co-practice', by which they refer to joint technical activities between units. The authors argued that R&D co-practice is an important facilitator of knowledge integration for global innovation strategies of multinational. The authors defined knowledge integration as the utilization by one multinational subunit of knowledge originating in another. According to the authors, R&D co-practice increases levels of absorptive capacity and social capital among participating units, and improves the likelihood that they will share knowledge at future points in time. The study was based on a panel dataset covering 104 multinationals in the automotive and pharmaceuticals sectors over a 21 year period. Data primarily comprised of the U.S. patent records and the headquarters-subsidiary dyad was the unit of analysis. The authors used citations by a headquarters patent to a prior subsidiary patent for measuring reverse knowledge integration. The authors found that R&D co-practice was devised by management as an explicit attempt to build cooperation across subunits with concrete objectives like new product development, and to improve learning and development of social capital.

Recognizing that learning and innovation are important determinants of multinational firm performance, Venaik, *et. al.* (2005) aimed to understand the organizational paths that lead to greater learning and increased innovation, and hence improved firm performance. The authors adopted the resource-based view and the structure-conduct-performance framework. Based on a survey of managers in subsidiaries of multinational firms, the authors found dual, independent paths to improved firm performance—one through networking and inter-unit learning and another through subsidiary autonomy and innovation. The study focused on marketing knowledge and marketing innovations. The studies empirical findings imply that even though both inter-unit learning and innovation lead to improved firm performance, their antecedents are different—networking significantly influences inter-unit learning but not innovation and autonomy fosters innovation but not inter-unit learning.

Singh (2007) examined knowledge flows in multinational firms and found significant inflows and outflows of knowledge between firm headquarters and host country R&D organizations. The study found that the knowledge outflows to the firm headquarters significantly outweigh knowledge inflows particularly when the foreign R&D sites are located in technologically advanced countries. In a recent study, Singh (2008) explored the impact of geographical dispersion of a firm's R&D activities on the quality of its innovative output. Geographical diversification allows a firm the opportunity to access and integrate globally dispersed knowledge to enhance its innovative capability. However, geographical distance may affect a firm's ability to effectively and efficiently integrate the globally distributed knowledge. Absent the effective integration of globally dispersed knowledge, a firm may not be able to gainfully leverage geographical diversification but yet incur considerable coordination costs. Based on an extensive analysis of more than half a million patents from 1127 firms, Singh (2008) found that the quality of innovative output in globally distributed R&D was directly related to the level of inter-unit integration of geographically dispersed units.

Kotabe, *et. al.* (2007) examined the determinants of cross-border knowledge flow and their impact on the innovative performance of multinational corporations. The study employed the resource-based perspective and was based on 56027 U.S. patents owned by 53 U.S. headquartered pharmaceutical firms industry. The results of the study showed that international knowledge transfer has an inverted U-shaped relationship with a firm's innovative performance. The study found that at low and moderate levels of international knowledge content, international knowledge transfer improves a firm's innovative performance. However, as the level of knowledge content increases, the return to innovative performance from international transfer of knowledge diminishes. This is because transferring high levels of international knowledge content necessitate increase in knowledge diversity that may fall beyond acceptable levels of effective communication and coordination. In addition, the findings also supported the authors' argument that firms transfer knowledge from fewer select locations to achieve focus and efficient deployment of resources for knowledge integration.

Song and Shin (2008) investigated the factors that influence the extent to which the headquarters of multinational firms source knowledge from the host countries of its overseas R&D labs. The authors posit that while the technological capabilities of a firm's headquarters enhance its learning capability because of absorptive capacity, they may also negatively impact headquarters motivation to source knowledge from host countries owing to its already established technological trajectory. The authors introduce the notion of absolute and relative levels of technological capabilities, and argue that relative levels of technological capabilities may motivate the firm headquarters to source knowledge from the host countries of its foreign R&D labs. The study drew on absorptive capacity perspective and the evolutionary theory of the firm, and analyzed U.S. patent citations from the semiconductor industry to trace knowledge flows from host countries to firm headquarters. The findings suggest that a firm's headquarters sources knowledge from host countries of its global R&D sites that have relatively stronger technological capabilities. The study also found an inverted U-shaped relationship between headquarters' technological capabilities and the level of its knowledge sourcing from a host country.

Summary: Several important observations can be derived from the literature review. First, despite clearly noticeable trends towards growth in global R&D activities, studies examining R&D globalization and innovative capability are still small in number. Second, studies that examine innovative capability in an integrative manner are indeed very few (Bartlett and Ghoshal, 2002; Venaik, *et. al.*, 2005). As seen from the review above, most studies examine either the influence of organizational structure on innovation performance or aspects related to knowledge transfer and integration. Third, a majority of the literature pertains to subsidiaries with own product-market mandate; as such, studies that focus on exclusive R&D subsidiaries are not readily distinguishable. Moreover, only one study (Frost and Zhou, 2005) deals with distributed, participative innovation (called R&D co-practice by the authors), which resembles the modus operandi in offshoring of R&D. Fourth, the research on knowledge transfer in multinational corporations has generally focused on flow of knowledge from headquarters to subsidiary or among geographically dispersed subsidiaries. Only few studies explicitly illuminate on aspects related to reverse transfer of knowledge from subsidiaries to headquarters (Frost and Zhou, 2005; Song and Shin, 2008). Fifth, most of the extant research on R&D globalization addressing innovative capability is quantitative in nature, and such as there is a dearth of studies that provide the 'inside' view and illuminate on organizational and management processes. Moreover, many of the studies exclusively rely on patent data as a proxy for innovative capabilities, which has many drawbacks[2] (Song and Shin, 2008).

2.2.4 Global R&D Subsidiary Management

A subsidiary is an operational unit located in a foreign country that is owned and controlled by the multinational firm (Birkinshaw, 1997). Scholars have traditionally

[2] There are several drawbacks of using patent data as a proxy for innovative capabilities. First of all, propensity of firms to patent their innovations varies across industries. Second, since a patent itself represents codified knowledge, it cannot be used to capture the tacit knowledge dimension. Third, for strategic reasons many firms simply focus on increasing the number of their patents, although such patents may have very little to do with their innovative performance (Song and Shin, 2008).

viewed a subsidiary in terms of stock of "relative capabilities" whose role is determined by the parent and enacted through appropriate control and coordination mechanisms (Bartlett and Ghoshal, 2002; Gupta and Govindarajan, 1991; Birkinshaw, 1997). The subsidiary level literature focuses on configurations of strategy and structure in subsidiaries of multinational corporations, subsidiary management practices and performance, and subsidiary's contributory role within the multinational network (Birkinshaw and Morrison, 1995, Birkinshaw, 1997; Birkinshaw, 2001).

For example, in a quantitative study of Canadian subsidiaries of multinational companies, Birkinshaw and Morrison (1995) found that a subsidiary's role could vary from having a world mandate to being a specialized contributor to serving as a local implementer depending on the structural characteristics of its relationship with the parent. The local implementer role of a subsidiary is confined to adapting products to local market requirements. In a specialized contributor role, the subsidiary develops components or products under assignment and direction from the headquarters, whereas the subsidiary is given full responsibility and authority for a product or product line when it is chartered with a world product mandate (Birkinshaw, 1996).

In a related study, Birkinshaw, *et. al.* (1998) found that in addition to assignment by the headquarters and the structural context of the subsidiary, several internal factors determine the contributory role of a subsidiary. These include subsidiary's internal resources and capabilities, entrepreneurial leadership, and aspirations of subsidiary managers and their initiatives (Birkinshaw, 1997). In a yet another related study of how the capabilities and charter of subsidiaries evolve, Birkinshaw and Hood (1998) found that in addition to headquarters' assignment of the subsidiary's role and the structural characteristics of the subsidiary's relationship with its parent, a set of subsidiary specific as well as host country specific factors also influence subsidiary evolution. The key subsidiary specific factors are track record of the subsidiary, credibility of subsidiary management, and entrepreneurial orientation of subsidiary employees, whereas the key host country factors include strategic importance of the country and relative cost of factors inputs.

The ability of a firm to leverage the stock of competence of its globally dispersed subsidiaries is an important source of its innovative capability (Bartlett and Ghoshal, 2002; Mudambi, *et. al.*, 2007). As such, the type and level of a subsidiary's competence influences the innovative capability of its parent firm. Researchers have claimed that the role of the subsidiary within the multinational firm depends not only upon its level and type of competence but also on the extent to which its competence is recognized and used by the other units within the firm (Forsgren, *et. al.*, 2000). Moreover, the level of subsidiary's competence positively affects the transfer of competence to other units within the multinational firm (Holm and Pedersen, 2000).

Rugman and Verbeke (2001) argue that the existence of a capability gap between the subsidiary and the other units determines the role and prominence of the subsidiary in the multinational network.

Several scholars have studied aspects related to the development and exploitation of subsidiary's stock of competence and its impact on the innovative capability of the multinational firm. For example, Furu (2001) investigated drivers of competence development in foreign R&D subsidiaries of multinational firms, and how such drivers influence the role of the subsidiary. The author's study was based on a survey of 468 multinational subsidiaries. The results suggest that subsidiaries with high levels of competence exhibit strategic investment in competence development and are also deeply embedded in their local business environment. Based on the findings, the author asserts that a strategic approach to competence development in subsidiaries is a critical requirement for them to create value for the multinational firm.

Andersson, *et. al.* (2002) studied the impact of subsidiary's external network on its competence development and performance. Based on a study of 97 Swedish multinational company subsidiaries, the authors argue that the external network in which a subsidiary is embedded is a resource in itself and can facilitate subsidiary's competence development, which, in turn, through knowledge transfer, enhances the multinational firm's innovative capability. However, the process of interaction between the subsidiary and its local environment is complex and idiosyncratic, and results in development of competence that is context specific. The authors contend that such context specificity could serve as a barrier to knowledge transfer from the subsidiary to other units of the firm.

Frost *et. al.* (2002) examined conditions that facilitate emergence of centers of excellence in foreign subsidiaries of multinational firms. The authors define a center of excellence as "an organizational unit that embodies a collection of capabilities that has been explicitly recognized by the firm as an important source of value creation, with the intention that these capabilities be leveraged by and/or disseminated to other parts of the firm". The study, based on a survey of 99 subsidiaries of foreign companies in Canada, found that the formation of centers of excellence is influenced by the subsidiary's local environment as well as investment made by the parent firm and the degree of autonomy granted to the subsidiary by the firm.

The R&D intensity and focus varies across subsidiaries of a multinational firm. Some subsidiaries may be bestowed with a competence creation mandate while the others may focus on competence exploitation. Cantwell and Mudambi (2005) suggest that whether a subsidiary focuses on competence creating or competence exploiting R&D depends on the location of the subsidiary, its local embeddedness, and the degree of autonomy available to it. In a survey of U.K. subsidiaries of non-U.K. companies with data at the levels of industry, location, and subsidiary, the authors found that a competence creating R&D mandate is obtained by those subsidiaries that are located in regions of technological excellence and have achieved strategic independence (i.e., autonomy).

Using motivational theory as the theoretical underpinning, Mudambi *et. al.* (2007) examined the organizational conditions that are associated with higher levels of subsidiary innovative output. In a survey of 275 globally dispersed R&D subsidiaries of multinational firms, the authors found that subsidiary self-determination and teamwork (inter-subsidiary and intra-firm) significantly affected subsidiary's innovative output, as measured by patent citations. The degree of autonomy and self-determination (empowerment) underlie intrinsic motivation of subsidiary teams, whereas teamwork is essential for generation of innovative outputs (Nonaka and Takeuchi, 1995; Brown and Eisenhardt, 1995). The authors posit that teamwork serves as an integration mechanism that can also reduce intra-organizational tension between the subsidiary and the firm headquarters and foster knowledge creation. The results of the study also support the assertion that the extent of autonomy and integration of R&D subsidiary depends on the nature of its knowledge assets (Birkinshaw, *et. al.*, 2002).

Finally, the ability of a subsidiary to generate innovations based on stimuli and resources in the host country environment is an important source of competitive advantage for multinational firms (Hedlund, 1986; Bartlett and Ghoshal, 2002; Hakanson and Nobel, 1993). Drawing on the multinational management literature as well as the broader literature on external sources of innovation, Frost (2001) advanced a set of hypothesis aimed at understanding the geographic source of knowledge for subsidiary's innovative activities. He tested the hypotheses through citation analysis of 10000 patents issued to U.S. subsidiaries of foreign multinational firms and found that when the innovation is exploitative in nature, its source is likely to be in the home base of the multinational firm. However, when a subsidiary pursues innovative activities of exploratory nature, then it is more likely to draw ideas and knowledge from its host environment.

Summary: The review of the literature suggests that the even though the role of the R&D subsidiary is assigned by the multinational firm headquarters, subsidiary's stock of knowledge and its ability to take initiatives also influences its contributory role. With growing intensification of technological competition, a firm's ability to harness the knowledge and competence of its geographically dispersed R&D units assumes significance for its innovative capability. Therefore, both the level of subsidiary's competence stock and its integration into the firm are important considerations. The type and quality of the stock of subsidiary competence determines knowledge transfer between the subsidiary and other units of the multinational firm. The extent of teamwork between the subsidiary and the other units of the firm facilitates knowledge transfer and integration. However, barring a few exceptions (Furu, 2001; Mudambi, *et. al.*, 2001), the extant literature on subsidiary management does not specifically deal with exclusive R&D subsidiaries. Most studies relate to subsidiaries that have product-market mandate or exist to cater to local or regional markets. An exclusive R&D subsidiary more closely resembles an offshore R&D organization that provides technological capabilities to the firm but does not have a product-market mandate. Moreover, almost all the published studies focus on multinational subsidiaries in developed countries and as such don't correspond with developing country contexts, where the phenomenon of offshoring of R&D is actually unfolding.

2.3 R&D EXTERNALIZATION

The literature on externalization of R&D is rather diverse and encompasses R&D alliances, R&D partnerships, and R&D outsourcing among other forms of inter-firm R&D collaboration (Chiesa and Manzini, 1998). R&D externalization refers to an instance when a firm engages or collaborates with another firm to achieve (part of) its R&D objectives (Howells, 1999a, 1999b). Externalization of R&D augments a firm's innovative capability through shared resources and mutual learning (Eisenhardt and Schoonhoven, 1996; Teece, *et. al.*, 1997; Hagedoorn and Duysters, 2002). Research also suggests that externalization of R&D is complementary to a firm's internal R&D efforts, provided the firm possesses the requisite absorptive capacity (Veugelers, 1997). That is, the marginal returns to internal R&D increases with increase in the intensity of R&D externalization (Veugelers and Cassiman, 1999; Cassiman and Veugelers, 2006). Firms exercise a choice of equity-based or contractual non-equity alliances to access R&D capabilities and achieve innovation objectives (Hagedoorn and Narula, 1996).

Several researchers have analyzed the trends in externalization of R&D at an international level (Narula and Hagedoorn, 1999; Murray, 2001; Hagedoorn, 2002). The analyses suggest that firms in the high-tech sectors show a propensity towards externalization of R&D internationally, arguably because of their competitive needs for innovation and flexibility. Trend analyses also suggest that high tech firms prefer non-equity, contractual arrangements over equity-based alliances in pursuing international externalization of their R&D activities (Hagedoorn and Narula, 1996; Narula and Hagedoorn, 1999). Since this research is concerned with inter-firm offshoring of R&D, i.e., offshore R&D outsourcing (Kotabe, 1998), only the relevant literature on R&D outsourcing is reviewed.

There has been a considerable rise in outsourcing of R&D activities over the last two decades (Jonash, 1996; Howells, 1999a, 1999b; Narula, 2001; Balachandra, 2005). Outsourcing of R&D refers to "work of an innovative nature undertaken by one party on behalf of another under conditions laid out in a contract agreed formally beforehand" (Howells, 1999a). In R&D outsourcing, a company externalizes R&D activities, i.e., engages another firm to perform R&D activities on its behalf, and, then, simply acquires the relative output (Chiesa and Manzini, 1998). R&D outsourcing is a non-equity partnership agreement with a customer-supplier relationship (Narula and Hagedoorn, 1999).

R&D outsourcing is a powerful tool for reduced cost, improved efficiency, reduced risks, and improved innovative capacity and flexibility (Howells, 1999a; Barringer and Harrison, 2000; Zhao and Calantone, 2003; Barthelemy, 2003; Quelin and Duhamel, 2003; Ryan, *et. al.*, 2004; Balachandra, 2005). Outsourcing of R&D on a global scale allows a firm to access (a) 24/7 R&D processes to accelerate innovation speed and (b) specialized capabilities and complementary assets to generate new and diverse innovations (Hipp and Gassmann, 1999; Hagedoorn, 2002; Balachandra, 2005). On the other hand, scholars have also highlight several disadvantages associated with R&D outsourcing, the key ones being loss of skills, dilution of organizational knowledge, weakened innovative capability, high coordination and transaction costs, and business risks stemming from overdependence on partners (Bettis, *et. al.*, 1992; Domberger, 1998; Hipp and Gassmann, 1999; Barringer and Harrison, 2000; Ryan, *et. al.*, 2004).

Most of the existing literature on R&D outsourcing focuses on the choice between internal and external R&D based on transaction costs and property rights considerations (Pisano, 1990; Veugelers, 1997; Vining and Globerman, 1999; Narula, 2001; Swan and Allred, 2003). However, scholars have argued that although the potential competitive hazards such as threat of opportunism, asset specificity and appropriability associated with outsourcing of R&D warrant consideration (Williamson, 1985), a firm's capabilities also play a role in determining its boundary and influence R&D outsourcing decisions (Barney, 1999; Mayer and Salomon, 2006). The capabilities based view of R&D outsourcing, which is often referred to as the core competency perspective (Prahalad and Hamel, 1990), emphasizes that firms should retain their core R&D activities in-house and outsource the non-core R&D activities (Quinn, *et. al.*, 1997; Domberger, 1998). Core competencies are those competencies that a firm can leverage to create unique value for its customers while maximizing potential profits. Core competencies provide a flexible knowledge and capabilities platform to a firm for creating continuous innovations (Prahalad and Hamel, 1990).

Quinn, *et. al.* (1997) argue that firms should focus on their "core competencies" and strategically integrate R&D outsourcing into their innovation value chain to achieve leverageable advantage. According to Quinn, *et. al.* (1997), a core competency driven approach to outsourcing is especially helpful in environments characterized by rapid technological and market change. Such an approach focuses on leveraging specialized innovative capabilities of outsourcing vendors rather than only short-term cost reduction, and leads to better, faster innovations at lower capital investment and decreased risks while considerably expanding flexibility (Quinn and Hilmer, 1994; Quinn, 1999). Strategic outsourcing also confers upon a firm the ability to adjust the scale and scope of innovation activities at low cost and rapid rate (Domberger, 1998). A firm can develop the capability to produce a mix of products and variants and pursue new product development projects without changing the size of its workforce by leveraging the manpower flexibility offered by its outsourcing partner network (Nishiguchi, 1994). Thus, a strategic approach to outsourcing enables a firm to exploit scale economics, maximize operating efficiency, and gain flexibility (Domberger, 1998).

However, several scholars have challenged the universal merit of core competency based approach to R&D outsourcing (e.g., Quelin and Duhamel, 2003; Baden-Fuller, *et. al.*, 2000). According to Quelin and Duhamel (2003), there are several types of core activities and hence activities critical to performance must be distinguished from those that create competitive advantage. Contrary to the established wisdom, Baden-Fuller, *et. al.* (2000) argue that under certain circumstances outsourcing core R&D activities may be beneficial to a firm. Illustrating with case studies, the authors suggest that when a firm is in catch-up mode with its competitors, or when it must respond to changing customer needs, or when its core is outdated due to technological shifts, or when new markets emerge due to rapid changes in customer demands and technology, R&D outsourcing is particularly helpful.

The choice between pursuing R&D activities internally versus outsourcing R&D is determined by characteristics of technology as well as its pace of change, dynamism in the market, availability of multiple substitutable R&D outsourcing vendors, and various strategic and economic issues associated with the firm competitiveness (Narula, 2001; Swan and Allred, 2003). Fine (1998) argues that firms should pursue outsourcing only to gain access to R&D capacity and not have any dependency on their partners for knowledge. Balachandra (2005) suggests that firms should consider outsourcing R&D only for incremental innovations that involve familiar technologies and are targeted at existing markets. Chesbrough and Teece (1996) suggest that firms should pursue R&D outsourcing for creation of autonomous innovations and confine all systemic innovation R&D in-house. Autonomous innovations are those innovations that can be developed independent of other innovations, whereas systemic innovations can be realized only in conjunction with other related or complementary innovations (Chesbrough and Teece, 1996).

Several empirical studies have investigated learning and knowledge integration in R&D alliances (Hamel, 1991; Mowery, *et. al.*, 1996; Steensma and Corley, 2000;

Powell, *et. al.*, 1996; Sampson, 2007). These studies suggest that merely accessing a partner firm's skills under an agreed-upon arrangement is not the same as actually internalizing partner's capabilities for organizational learning (Hamel, 1991). The ability of a firm to learn from its alliance partner depends on the degree of coupling between them. When the interdependencies between two partners is higher, the coupling between them is tighter, which leads to richer communication and interaction channels, and promotes learning and knowledge integration (Mowery, *et. al.*, 1996; Steensma and Corley, 2000). In an empirical examination of 463 R&D alliances Sampson (2007) found that a firm's innovative performance improves when it can access and leverage the technological diversity of its alliance partner. However, international R&D alliances are qualitatively different from global outsourcing of R&D because in an alliance the primary concern is to deploy shared R&D resources to achieve a common innovation objective (Chiesa and Manzini, 1998).

Based on an empirical study, Ingham and Mothe (1998) suggest that a set of behavioral and structural factors influence organizational learning in R&D partnerships. The behavioral factors include motivation to learn, trust between partners, and intensity of interaction between partners, whereas the structural factors concern the nature of knowledge tacit/codified), division of tasks, and experience in internal R&D (Ingham and Mothe, 1998). Gilley and Rasheed (2000) in their empirical study aimed at evaluating the impact of outsourcing on firm performance found that outsourcing did not have any significant negative impact on a firm's innovation performance. Their study suggests positive impact of outsourcing on the performance of those firms that pursue cost leadership as well as an enhanced innovation focus through outsourcing of peripheral innovation tasks (Gilley and Rasheed, 2000).

Organizational scholars have employed the knowledge based view to empirically examine the impact of external R&D sourcing on firm's R&D performance (Kessler, *et. al.*, 2000; Becker and Zirpoli, 2003; Fey and Birkinshaw, 2005). These studies conclude that R&D outsourcing is negatively related to organizational learning due to the inherent difficulties in transferring tacit knowledge in an inter-organizational setting (Kessler, *et. al.*, 2000; Fey and Birkinshaw, 2005). Based on a case study of automotive product development, Becker and Zirpoli (2003) conclude that despite its short-term benefits outsourcing results in hallowing out of competence in the long-term. Beneito (2006) suggests that R&D outsourcing is more suitable for innovations of incremental nature that do not require intensive information exchange.

The tacit nature of R&D activities and the downside associated with hallowing out of knowledge and loss of technological competitiveness encourages firms to internalize their R&D activities (Narula, 2001). However, numerous studies suggest the efficacy of relational governance in alleviating the potential contractual and competitive hazards involved in outsourcing of R&D (Nishiguchi, 1994; Dyer and Singh, 1998; Domberger, 1998; Mol, 2005; Cason, *et. al.*, 2006). Relational outsourcing or outsourcing partnerships (Domberger, 1998) are inter-organizational relationships bases on trust, reputation, shared values, and demonstrated commitments to suppliers to engage in repeated exchange. Such inter-organizational relationships are governed through self-enforcing mechanisms (Dyer, 1997; Dyer and Singh, 1998). Relational outsourcing results in specialized knowledge, provides endowments of complementary capabilities, and leads to development of inter-organizational routines that not only promote knowledge sharing and integration but also improved organizational flexibility (Dyer and Singh, 1998; Lorenzoni and Lipparini, 1999; Hagedoorn and Duysters, 2002; Dyer and Chu, 2003; Cesaroni, 2004; Ryan, *et. al.*, 2004; Casson, *et. al.*, 2006).

Summary: Most studies pertaining to externalization of R&D on a global scale focus either on the internalization versus externalization decision or on determination of mode of R&D externalization (Hagedoorn and Narula, 1996; Almeida, *et. al.*, 2002). While some researchers have investigated aspects related to organizational learning and firm performance in the context of international strategic alliances (Hamel, 1991; Mowery, *et. al.*, 1996; Narula and Hagedoorn, 1999; Murray, 2001), the extant literature on global R&D outsourcing is rather scant. As such, studies examining aspects of innovative capability and organizational flexibility in global outsourcing of R&D are not readily evident. Moreover, there is confusion among scholars in the use of the term "offshoring of R&D" since it has been interchangeably used with global R&D outsourcing (e.g., Balachandra, 2005).

2.4 CONCLUSIONS

As discussed in the beginning of this chapter, extant literature that can directly inform the present inquiry is not available. Therefore, this chapter focused on reviewing relevant parts of the extant literature on globalization of R&D, of which offshoring of R&D may be viewed as a part, with the aim to identify insights that can potentially guide the inquiry. The literature review also enfolded a brief review of the literature on R&D externalization, particularly, R&D outsourcing. This is because the focus of this research includes both intra-firm and inter-firm offshoring of R&D. The literature review reveals that while aspects related to organizational flexibility have not been examined in the context of globalization of R&D yet, limited studies exist that explore aspects of innovative capability. Researchers have either explored organizational structure – innovation performance relationship or examined aspects related to knowledge creation, transfer and integration in studies of R&D globalization. However, the construct of innovative capability does not appear to be well-defined in the R&D globalization literature. Therefore, there is a need to not only review the literature on organizational flexibility, but also organization innovation so as to comprehensively understand the construct of innovative capability.

Nevertheless, taken together, the R&D globalization literature provides several useful insights that this research can benefit from. First, the literature suggests the headquarters-subsidiary relationship can be modeled as principal-agent relationship, implying applicability of agency theory for governance of global R&D organizations of a multinational firm. Second, the literature points out that the control and coordination structure for a global R&D unit depends on its type (why the unit exists) as well as the nature of its R&D activities (what the unit does). Third, it is evident from the literature that the mode of control and choice of coordination mechanisms significantly influence the innovative performance of the global R&D unit. The literature review suggests that centralization, formalization, socialization, and communication together can constitute a fairly comprehensive characterization of the structure of firm headquarters – global R&D organization relations (Martinez and Jarillo, 1989, 1991; Nohria and Ghoshal, 1997; Bartlett and Ghoshal, 2002; Nobel and Birkinshaw, 1998; Persaud, 2005).

The ability to transfer knowledge is an important source of a multinational firm’s ability to develop, share and leverage knowledge (Bartlett and Ghoshal, 2002; Gupta and Govindarajan, 1991). The literature suggests that both characteristics of knowledge and organizational design considerations are important determinants of knowledge transfer (Gupta and Govindarajan, 2000; Foss and Pedersen; 2004). The organizational design considerations include deploying formal and informal integrative mechanisms that facilitate knowledge transfer (De Meyer, 1993a; Gupta and Govindarajan, 2000; Foss and Pedersen; 2002, 2004). The literature also indicates that organizational dynamics also affect knowledge transfer (De Meyer, 1993a; Gupta and Govindarajan, 2000). Review of the literature also suggests that a global R&D subsidiary’s ability to take meaningful initiatives may also contribute to the parent firm’s innovative capability (Birkinshaw, 1997).

In the next chapter, the construct of innovative capability and the concept of organizational flexibility are explicated. Also, drawing from the mainstream organizational innovation literature as well as organizational economics and strategic management theories, the key insights surfaced by the literature review are further explored in the next chapter to discern theoretical underpinnings for this inquiry.

CHAPTER 3
THEORETICAL UNDERPINNINGS

THE PURPOSE OF this chapter is to build on insights derived from the review of the R&D globalization literature in Chapter 2, and discern theoretical underpinnings that can shed light on the phenomenon of interest in this research. As mentioned in Chapter 1, this research seeks to understand the association between offshoring of R&D and a firm's innovative capability and organizational flexibility. However, the scholarly literature on offshoring of R&D is yet to develop, and as shown in Chapter 2, the extant literature on R&D globalization does not directly illuminate on the focal aspects of this study. This is primarily because offshoring of R&D is a new organizational form and its contours are not yet explicitly understood. Specifically, an understanding of the type of offshore R&D units and their R&D activities does not exist. As a result, application of the insights gained from the R&D globalization literature to study of offshoring of R&D warrants due considerations of the contextual characteristics of offshore R&D organizations.

Also, while some literature is available that addresses aspects related to innovative capability in the context of R&D globalization, the literature linking globalization of R&D and organization flexibility does not exist. Moreover, as established in Chapter 2, the extant R&D globalization literature has not treated the construct of innovative capability in an integrative manner. As such, most studies have either investigated the organization structure – innovative capability link or focused on knowledge transfer in global R&D operations. Innovative capability is a multidimensional construct (Lawson and Samson, 2001). Therefore, this chapter delves into the literature on innovation to explicate the construct of innovative capability. In addition, this chapter discusses the concept of organizational flexibility and reviews the key literature associated with the concept. Also, since Chapter 2 highlighted the relevance of the principal-agent relationship theory for governance of global R&D units, a review of agency theory (Eisenhardt, 1989a) is included in this chapter.

This chapter also includes a review of the dynamic capabilities perspective from the strategic management literature (Teece, *et. al.*, 1997; Eisenhardt and Martin, 2000). Innovative capability and organizational flexibility are two key dynamic capabilities for high technology firms (Wang and Ahmed, 2007). Hence, the dynamic capabilities perspective can provide an overarching theoretical base for this inquiry. The chapter is organized as follows: First, two strands of the innovation literature, namely (a) organization structure – innovation and (b) knowledge creation, knowledge transfer, knowledge integration and innovation are reviewed in Section 4.2 to achieve an integrative understanding of the construct of innovative capability. Next, Section 4.3 provides a discussion on organizational flexibility and reviews the key literature. Then, agency theory is reviewed in Section 4.4 followed by a review of the dynamic capabilities perspective in Section 4.5. Finally, Section 4.6 wraps up the chapter with a summary.

3.1 INNOVATIVE CAPABILITY

Innovation is a key business process for success, survival and organizational renewal of high technology firms (Lengnick-Hall, 1992; Brown and Eisenhardt, 1995). Innovation is a way for firms to adapt to changes in their internal or external environment, or take a preemptive action to influence their environment (Damanpour, 1991; Dougherty, 1992; Eisenhardt and Tabrizi, 1995). Therefore, innovation is central to economic development (OECD, 2006). According to Schumpeter (1983), innovation means “introducing and carrying out new combinations” to create new goods, new production methods, new markets, and new organizational forms. Van den Ven (1986) defines innovation as a new idea, which may be a recombination of old ideas, or a scheme, or a unique approach that challenges the present order. The ability to create and harness knowledge is central to the process of innovation (Nonaka and Takeuchi, 1995). R&D is a key source of innovation (Lengnick-Hall, 1992; Gupta, *et. al.,* 2007).

Broadly speaking, the term “innovative capability” refers to the ability of a firm to generate innovative outputs. It concerns the specific expertise and competence related to the development and introduction of new products, technologies, and processes (Hagadoorn and Duysters, 2002). The concept of innovative capability has not been extensively covered in the innovation literature. Moreover, the concept has been variously defined in the literature and as such there is an issue of inconsistent semantics in relation to the concept. The concepts innovative ability, innovative capacity (McGrath, 2001), learning capacity (Child, 2003; Cohen and Levinthal, 1990), “integrative capability” (Lawrence and Lorsch, 1967; Grant, 1996b) and “combinative capability” (Kogut and Zander, 1992) seem to all relate to the same concept of innovative capability, relating it to creation of innovation.

Essentially, innovative capability is concerned with production of innovations (Schoonhoven, *et. al.*, 1990; Ravichandran, 2000). It is a multidimensional concept composed of reinforcing capabilities, processes and practices within a firm (Lawson and Samson, 2001). Two different research strands can be discerned from the literature on innovation, which are relevant for studying innovative capability: (1) Organizational Structure – Innovative Capability and (2) Knowledge Creation, Knowledge Transfer, Knowledge Integration, and Innovation (Lam, 2005). The ‘organizational structure – innovative capability’ strand focuses on the impact of organizational design characteristics and attributes on innovative capability (Burns and Stalker, 1961; Lawrence and Lorsch, 1967; Damanpour, 1991). The 'knowledge creation, knowledge transfer, knowledge integration, and innovation' strand concerns creation, mobilization and transformation of knowledge for generation of innovation (Kogut and Zander, 1992; Grant, 1996a, 1996b; Leonard, 1995; Nonaka and Takeuchi, 1995). In what follows, the key ideas and literature pertaining to these two strands are reviewed.

3.1.1 Organizational Structure and Innovative Capability

Rooted in theories of organizational design, the predominant focus in this research strand is to understand the link between structural forms (i.e., organizational structure)[1] and the innovative capability of an organization (Burns and Stalker, 1961; Lawrence and Lorsch, 1967). The main research aim is to identify the structural characteristics of an organization, and to understand how the structural variables affect innovative capability. In this strand, the organization is the unit of analysis and innovation is treated as an outcome of organization structure (Lam, 2005).

Burns and Stalker (1961) have described two kinds of structural forms: mechanistic and organic. A mechanistic structure is characterized by specialization and differentiation of functional tasks, hierarchical controls, authority and communication, prominent superior-subordinate interactions, and governance through formal instructions and top-down decisions. A 'mechanistic' organization is appropriate when the business environment is stable. On the other hand, the organic form of organization is characterized by the contributive nature of the specialized knowledge and experience to the common task of the concern, continual redefinition of individual tasks through interaction with others, a network structure of control and lateral communication, flow of information, advice and consultation rather than instructions, and meritocracy rather than seniority. On the other hand, an 'organic' organization is effective when a firm operates in a dynamic business environment (Burns and Stalker, 1961).

Three structural characteristics have been commonly discussed in the literature on innovation: centralization, formalization, and socialization (Damanpour, 1991, Pierce and Delbecq, 1977; Jansen, *et. al.*, 2006). Centralization refers to the degree to which the locus of control and decision-making is concentrated in an organization in the hands of a few people (Galbraith, 1973; Damanpour, 1991; Rogers, 1995). Formalization refers to the degree to which an organization emphasizes following written rules and procedures in the role performance of its members (Galbraith, 1973; Damanpour, 1991; Rogers, 1995). Centralization and formalization are means to exercise behavioral control (Cardinal, 2001). Finally, socialization, or connectedness

[1] An organizational structure is a tool for coordinating and integrating innovative activities performed by organizational members (Cardinal, 2001; Eisenhardt, 1985; Govindarajan and Gupta, 1985).

refers, to the degree to which organizational units and members are informally linked through interpersonal, social networks (Damanpour, 1991, Rogers, 1995, Pierce and Delbecq, 1977; Hurley and Hult, 1998; Jansen, *et. al.*, 2006).

Even though the results of innovation studies are inconsistent, non-cumulative, and often contradictory (Downs and Mohr, 1976; Wolfe, 1994; Fiol, 1996; Berglund, 2004), both centralization and formalization have are generally considered to hamper innovative capability. Socialization, on the other hand, is considered to be a strong facilitator of innovation (Damanpour, 1991; Jansen, *et. al.*, 2006). Also, the extent of internal and external communication has been found to have a positive correlation with an organization's innovative capability (Allen, 1977; Damanpour, 1991; Hurley and Hult, 1998).

There is a rich body of literature dealing with organizational attributes and determinants of innovative capability. Several empirical studies have examined the influence of organizational attributes such as age, size, complexity, slack, and culture on innovative capability. For example, scholars have found the size of an organization to be a positive determinant of its innovative capability (e.g., Pierce and Delbecq, 1977; Rogers, 1995; Damanpour, 1996; Hurley and Hult, 1998). On the other hand, the age of an organization has been found to be negatively related with innovative capability (Hurley and Hult, 1998; Leonard, 1995). Age leads to development of structural as well as cultural inertia, arising due to established organizational routines and institutionalized norms (Leonard, 1995; Tushman and O'Reilly, 1996).

Organizational complexity has also been found to be positively related to innovative capability (Rogers, 1995; Damanpour, 1996). Organizational complexity is a function of structural complexity and organizational size. An organization's structural complexity is dependent on the number of locations at which work is performed and the number of jobs and hierarchical roles performed within the organization (Damanpour, 1996). Such differentiation or diversity of specialization and occupational types promotes constructive conflict, reduces reliance on a single professional ideology, and enhance cross-fertilization of ideas, and results in higher innovative capability (Damanpour, 1996; Pierce and Delbecq, 1977; Ravichandran, 2000).

Organizational slack is also considered to be positively associated with an organization's innovative capability (Cyert and March, 1992; Damanpour, 1991; Rogers, 1995), although some scholars have argued that slack promotes indiscipline and opportunism (Jensen and Meckling, 1976). Slack is a pool of organizational resources (employees, capital, capacity, etc.) in excess of the minimum necessary to produce a given level of organizational output. Slack permits an organization to carry out experimentation and pursue innovative projects (Levinthal and March, 1981; Cyert and March, 1992; Nohria and Gulati, 1996; Rogers, 1995). Based on an empirical study, Nohria and Gulati (1996) have suggested that there is an inverse U-shaped relationship between slack and innovation, implying that an optimal level of slack is desired for effective innovative capability.

Researchers have also found that the attitude and intrinsic motivation of organizational members is positively correlated with innovative capability (Pierce and Delbecq, 1977). Job satisfaction, job involvement, and performance dissatisfaction have been found to positively influence innovative capability (Pierce and Delbecq, 1977). Research shows that organizational members develop negative attitude towards repetitive tasks. Therefore, providing employees with meaningful, creative, and challenging tasks enhances their motivation levels and improves innovative performance (Ravichandran, 2000).

3.1.2 Knowledge Creation, Knowledge Transfer, Knowledge Integration, and Innovative Capability

Knowledge creation is a critical input for continuous innovation (Nonaka and Takeuchi, 1995). Learning is the most fundamental process by which organizational knowledge is created (Nelson and Winter, 1982; Kogut and Zander, 1992). Knowledge is the most strategically important resource of the firm (Grant, 1991, 1996a, 2001). Therefore, an organization’s ability to create, mobilize and integrate knowledge is a source of its competitive advantage (Conner and Prahalad, 1996, Grant, 1996a; Kogut and Zander, 1992; Nonaka and Takeuchi, 1995). This research strand is rooted in the theories of organizational learning (Fiol and Lyles, 1985; Huber, 1991; Child, 2003) and knowledge based view of the firm (Grant, 1996a, 1996b). In this strand, innovative capability is viewed as a function of collective learning and knowledge creation, and the focus is on the micro-level organizational processes such as social interactions and how they shape collective learning, problem solving, knowledge creation and knowledge accumulation (Brown and Duguid, 1991; Nonaka and Takeuchi, 1995; Leonard, 1995; Kogut and Zander, 1992; Lam, 2005).

Organizations are essentially distributed knowledge systems because they are composed of knowledge embodied in individual members and their social interactions (Tsoukas, 1996). Learning processes are intrinsically social and collective, and knowledge is embedded in organizational members, tools, and tasks as well in an organization’s social structure (Dosi and Marengo, 2007; Hodgson, 1998). Thus, promotion of interactions among individuals situated in different parts assumes critical importance for knowledge creation in such distributed organizational systems (Tsoukas, 1996; Un and Cuervo-Cazurra, 2004; Nonaka, 1994). According to Nonaka and Takeuchi (1995), stimulating the interaction between the organization and its external environment, instilling knowledge redundancy, and maximizing information variety enable knowledge creation. Leonard (1995) suggests that creating porous organizational boundaries and nurturing boundary spanners improves organizational learning through assimilation of external knowledge. Systematically managing and leveraging the diversity in cognitive styles also improves knowledge creation (Leonard, 1995; Leonard and Strauss, 1997).

There are two types of knowledge: explicit knowledge and tacit knowledge. Explicit knowledge is knowledge that is codified, whereas tacit knowledge is the knowledge held by individuals and organizational routines (Kogut and Zander, 1992). Knowledge enlargement and enrichment happens through interaction of tacit and explicit knowledge (Nonaka, 1994; Nonaka and Takeuchi, 1995). Innovation can be understood as a process in which the organization creates and defines problems and then actively develops new knowledge to solve them (Nonaka, 1994). According to Nickerson and Zenger (2004), identification of valuable problems and the ability to conduct an efficient solution search is the key to developing valuable new knowledge. New learning, such as innovations, are products of a firm's combinative capabilities to generate new applications from existing knowledge (Kogut and Zander, 1992; Henderson and Cockburn, 1994). Combinative capability refers to the ability of a firm to synthesize and apply current and acquired knowledge (Kogut and Zander, 1992).

In the literature, there are two distinct views as regards the locus of knowledge within the firm: one emphasizes primacy of individual (Grant, 1996a) and another underscores the collective locus of knowledge (Kogut and Zander, 1992; Nelson and Winter, 1982; Tsoukas, 1996; Spender, 1996; Zollo and Winter, 2002). According to Grant (1996a, 1996b, 2001), knowledge creation is an individual activity, and the firm is essentially a knowledge integrating institution. Knowledge integration involves combining knowledge from different sources to generate new knowledge or to apply that knowledge to the creation of new products or services (Grant, 1996b; Eisenhardt and Santos, 2002). Accordingly, organizational capability is an outcome of knowledge integration (Grant, 1996a, 1996b, 2001). According to Kogut and Zander (1992), knowledge is held by individuals and yet it is also embedded in the organizing principles by which people cooperate in an organizational context. Because the creation of new knowledge depends on existing capabilities and organizing principles, the knowledge of the firm evolves through the replication and recombination of existing knowledge in a path-dependent way (Kogut and Zander; 1992; Nelson and Winter, 1982). Thus, this latter view emphasizes knowledge transfer as the basis of firm innovative capability. Knowledge integration does not necessarily imply knowledge transfer (Grant, 1996b; Eisenhardt and Santos, 2002).

For knowledge creation to be effective, both willingness of people to interact and share their knowledge, and common knowledge, are required (Leonard, 1995; Nonaka and Takeuchi, 1995). Therefore, it is important to understand the organizational processes through which the firms access and utilize the knowledge possessed by their individual members. Grant (1996b) identifies two broad mechanisms for knowledge integration: direction and organizational routines. Direction involves codification of tacit knowledge into explicit procedures and instructions. Direction enables faster knowledge integration at low cost. Organizational routines, on the other hand, facilitate integration of knowledge through coordination, interaction and collaboration among organizational members. Efficiency of knowledge integration depends on common knowledge, shared behavioral norms, frequency of communication, and organizational structures (Grant, 1996a, 1996b). "Communities of creation" provide common structure and meaning for exchange of experience and development of common knowledge (Brown and Duguid, 1991; Nonaka, 1994).

Dierickx and Cool (1989) have conceptualized the knowledge of the firm in terms of stock and flows. Stocks of knowledge are accumulated knowledge assets while flows are knowledge streams within and across organizations that contribute to the accumulation of knowledge (Dierickx and Cool, 1989). The flow or transfer of knowledge involves a source and a recipient. The effectiveness of knowledge transfer depends on the characteristics and attributes of knowledge (Szulanski, 1996). Explicit knowledge is revealed by its communication and is easy to transfer, whereas tacit knowledge is revealed through its application and is difficult to transfer (Grant, 1996a, 2001). Tacit knowledge is "sticky" and difficult to transfer because it is the product of organizational learning and is socially complex (Szulanski, 1996; Kogut and Zander, 1992; Grant, 1996a). The complexity (Hansen, 2002) and causal ambiguity (Szulanski, 1996) of knowledge also impact its transfer. Characteristics of both the source and recipient of knowledge are also important determinants of knowledge transfer (Szulanski, 1996). Lack of motivation and reluctance to share knowledge on the part of the source, recipient's lack of motivation and absorptive capacity (Cohen and Levinthal, 1990), and perception of the reliability of source's knowledge can all affect the process of knowledge transfer (Szulanski, 1996).

The relationship and distance between the source and recipient is also an important determinant of knowledge transfer (Szulanski, 1996; Gupta and Govindarajan, 2000; Eisenhardt and Santos, 2002; Singh, 2007). Organizational structures and culture also have a direct bearing on the ease of knowledge transfer (Fiol and Lyles, 1985; Nonaka and Takeuchi, 1995; Lam, 2005). Organizational-level integrative mechanisms such as socialization, routine communication, project teams, liaisons, and norms for collaboration facilitate knowledge transfer (Nohria and Ghoshal, 1997; Bartlett and Ghoshal, 2002; Gupta and Govindarajan, 2000; Eisenhardt and Galunic, 2000). Socialization not only facilitates transfer of knowledge (Hansen, 2002; Szulanski, 1996; Tasi, 2002; and Zander and Kogut, 1995) but also the creation of new knowledge (Nonaka and Takeuchi, 1995; Nahapiet and Ghoshal, 1998), which in turn enhances a firm's innovative capability (Tsai and Ghoshal, 1998; Subramaniam and Youndt, 2005).

In their discussions of procedural justice theory, Kim and Mauborgne (1991, 1996, and 1998) note that creating and sharing knowledge are intangible activities that can be neither supervised nor forced out of people. Therefore, the key challenge is to obtain the voluntary cooperation of people for which trust is an antecedent. Organizational members cooperate voluntarily when they perceive the strategic decision-making processes that affect them to be fair. When organizational members are involved in decisions that affect them, when they are asked for their inputs, when they are allowed to refute the merits of others' ideas and assumptions, and when they understand why decisions are made in a certain way, they show a propensity to cooperate voluntarily (Kim and Mauborgne, 1991, 1996, 1998). Procedural justice emphasizes intellectual recognition and emotional recognition. Intellectual recognition involves valuing people's knowledge and expertise and respecting their intellectual worth—when people are asked for their ideas and inputs, its signals their importance. Emotional recognition established fairness, feeling of dignified human being, respect and recognition (Kim and Mauborgne, 1991, 1996, 1998).

As noted earlier, learning is the most fundamental process by which organizational routines are formed and knowledge is created (Nelson and Winter, 1982; Kogut and Zander, 1992). A fundamental tension concerning development of organizational innovative capability is striking a balance between "exploitation of old certainties" and "exploration of new possibilities" (March, 1991). However, the types of learning and the learning trajectories differ between exploitation and exploration (Gupta, *et. al.*, 2006). Both exploitation and exploration are crucial and hence an organization must become ambidextrous to develop the capability to pursue both exploitative and exploratory innovation simultaneously (Tushman and O'Reilly, 1996). Finally, since organizational routines are path dependent (Nelson and Winter, 1982), they can be the source of cultural and structural rigidity and inertia, which can lead to the "familiarity trap" (favoring the familiar), the "maturity trap" (favoring the mature and proven), and the "propinquity trap" (favoring search for solutions near to existing solutions) and hamper learning and new knowledge (Leonard, 1995; Ahuja and Lampert, 2001).

Since the ability to effectively create, mobilize, and integrate knowledge is central to firm competitiveness, there appears to be a growing consensus among scholars to emphasize the knowledge dimension in their conceptualization of innovative capability (Lall, 1992; Kogut and Zander, 1992; Grant, 1996b; Prahalad and Hamel, 1990; Nonaka and Takeuchi, 1995; Leonard-Barton, 1995; Lam, 2005). For example, Lall (1992) defines innovative capability as the skills and knowledge needed to effectively absorb, master, and improve existing technologies, and to create new ones. Kogut and

Zander (1992) suggest that innovative capability is essentially the ability of a firm to mobilize the knowledge embodied in its employees and combine it to create new knowledge resulting in product and/or process innovations. Thus, innovative capability may be defined as the ability of a firm to create, mobilize, and transform knowledge to generate innovative outputs (Kogut and Zander, 1992; Grant, 1996b; Nonaka and Takeuchi, 1995; Leonard-Barton, 1995; Lam, 2005; Lawson and Samson, 2001; Subramaniam and Youndt, 2005).

3.1.3 Types of Innovative Capability

Innovative capability of a firm is expressed in the form of innovative outcomes (Lawson and Samson, 2001; Subramaniam and Youndt, 2005). An important classification of innovation is the distinction between incremental and radical innovation (Dewar and Dutton, 1986; Tushman and Anderson, 1986). Incremental innovations refine existing products, services or technologies. Radical innovations, on the other hand, are major transformations of existing products, services, or technologies (Tushman and Anderson, 1986; Ettlie, 2006). Thus, based on this classification, two types of innovative capabilities can be distinguished: incremental innovative capability and radical innovative capability. Incremental innovative capability refers to the ability of a firm to generate innovations that refine and reinforce existing products and services. Radical innovative capability refers to the ability of a firm to generate innovations that significantly transform existing products, technologies, or services (Subramaniam and Youndt, 2005).

Incremental innovative capability differs from radical innovative capability in terms of the type of knowledge that underpins it (Subramaniam and Youndt, 2005; Levinthal and March, 1993; Jensen, *et. al.*, 2006). An incremental innovation introduces relatively minor changes to the existing product, process, or technology, and improves price/performance advance at a rate consistent with the existing technological trajectory. Thus, incremental innovative capability entails reinforcement of existing competencies, skills and know-how. A radical innovation, on the other hand, signifies major advancements in the product, process, or technology that involves a shift to a new technological trajectory and results in a significant improvement on the price/performance frontier. Accordingly, radical innovative capability often entails obsolescing and overturning existing competencies, skills, and know-how (Abernathy and Clark, 1985; Tushman and Anderson, 1986; Henderson and Clark, 1990; Benner and Tushman, 2002; Ettlie, 2006). Incremental innovative capability is competence enhancing and exploitative, whereas radical innovative capability is competence destroying and exploratory (Levinthal and March, 1993; Anderson and Tushman, 1990; Berner and Tushman, 2003).

3.1.4 External Sources of Innovative Capability

External sources of knowledge are often critical to the innovation process (von Hippel, 1988: Lall, 1992), and provide diverse and complementary set of skills and capabilities required for growing complexity of innovation projects (Chiesa and Manzini, 1998). Therefore, the ability to recognize valuable external knowledge, assimilate it, and apply it for commercial gain, known as *absorptive capacity* (Cohen and Levinthal, 1990), is an important component of a firm's innovative capability (Henderson and Cockburn, 1994; Hagedoorn and Duysters, 2002). A firm's level of prior related knowledge determines its absorptive capacity, which develops in a path-dependent fashion. Investment in R&D has been found to be positively correlated to a firm's absorptive capacity (Cohen and Levinthal, 1989). Creating porous organizational boundaries, nurturing boundary spanners, and fighting the 'not invented here' (NIH) syndrome are important for effective absorption of external knowledge (Leonard, 1995).

In highly dynamic environments, where the speed and scope of knowledge integration are paramount for competitive performance, external knowledge sourcing increases opportunities for experimentation and learning (Kogut and Zander, 1992; Kogut, 2000; Grant, 1996b; Brown and Eisenhardt, 1997) and supports a variety of innovation objectives such as speed of product development and introduction of new products (Eisenhardt and Santos, 2002). However, distinguishing between systemic and autonomous innovations, Chesbrough and Teece (1996) have argued that relying on external sources of innovative capabilities is appropriate only when the innovation in question is autonomous. Innovations have also been categorized as autonomous and systemic. Autonomous innovations are those innovations that can be pursued independently from other innovations (products or processes). By contrast, systemic innovations are those innovations whose benefits can be realized only in conjunction with related, complementary innovations (Chesbrough and Teece, 1996; Teece, 1998).

Summary: Innovative capability may be defined as the ability of a firm to continuously create, mobilize, and transform knowledge to generate innovative outputs. The characteristics of the organizational structure impact a firm's innovative capability. A firm's competitiveness depends on its ability to simultaneously pursue goals for incremental and radical innovation, and produce requisite volume and variety of innovations. Therefore, both incremental and radical innovative capabilities are essential for competitive performance. The construct of innovative capability is measured by its outcome—the types and number of innovations generated by firms (Lawson and Samson, 2001; Subramaniam and Youndt, 2005). An innovation's success depends not only on how effective it is (Brown and Eisenhardt, 1995; Dougherty, 1992) but also how speedily it is introduced in the market (Lengnick-Hall, 1992; Schoonhoven, *et. al.,* 1990; Eisenhardt and Tabrizi, 1995; Gopalakrishnan, 2000;

Kessler and Chakrabarti, 1996). This suggests innovation speed to be an important outcome of the firm's innovative capability.

A firm's innovative capability is dynamic in nature in that it involves the interaction between a firm's internal knowledge and the demands of the external environment (Lawson and Samson, 2001; Wang and Ahmed, 2007). Ende, *et. al.* (2001) argue that firms need different innovative capabilities to operate successfully in different phases of the innovation lifecycle. Distinguishing between internal and external orientation of innovative capabilities at the level of the industry, Ende, *et. al.* (2001) suggest that in the early phase of an innovation lifecycle effective integration across functional areas and flexibility in product development constitute important internal capabilities, whereas effective management of demand oriented variation is an important internal capability that assumes importance in the later phase in the innovation lifecycle. Similarly, the ability to absorb and integrate external knowledge is an important external capability during the early stages of the innovation lifecycle, whereas the capability for fast-followership assumes importance in the later phase in the innovation lifecycle.

Innovative capability is dynamic in nature in that it requires continuous renewal of a firm's knowledge. Thus, the concept of innovation capability is related to the notion of dynamic capabilities (Lawson and Samson, 2001; Teece, *et. al.,* 1997). Strategic management scholars hold the view that firms do not compete on individual new innovations but rather on a deeper capability to generate new innovations continuously (Prahalad and Hamel, 1990). Viewed in this sense, innovative capability is a dynamic capability, which enables the firm to integrate key capabilities and resources to successfully stimulate innovation and respond effectively to its environment (Kogut and Zander, 1992; Teece, *et. al.*, 1997; Eisenhardt and Martin, 2000; Wang and Ahmed, 2007). Innovative capability encompasses the ability to access, understand and integrate external knowledge. Thus, innovative capability is a dynamic capability (Teece, *et. al.*, 1997) that comprises combinative capability (Kogut and Zander, 1992; Grant, 1996b) and absorptive capacity (Cohen and Levinthal, 1990).

3.2 ORGANIZATIONAL FLEXIBILITY

The new competitive landscape is characterized by unprecedented competitive intensity, market uncertainty, and technological discontinuities (Hitt, *et. al.*, 1998; Grewal and Tansuhaj, 2001). In order to survive and grow in such turbulent environments, firms need to possess organizational capabilities that enable them to continuously create innovative products and services in alignment with market demand (Chakravarthy, 1997). Increasingly, managers are faced with the task of creating a balance between "the stability necessary to allow development of strategic planning and decision processes and instability that necessitates continuous change and adaptations to a dynamic environment" (Hitt, *et. al.*, 1998). This is particularly true of high technology firms that face a frenzied pace of change due to confluence of technological and market uncertainties, characterized by compressed product and process life cycles, rapid pace of technological change, and narrow windows of market opportunities (Bahrami and Evans, 1989; Evans, 1991). As such, high technology firms need to become highly innovative and flexible (Grant, 1998; Teece, *et. al.*, 1997; Volberda, 1997; Dougherty and Hardy, 1996).

Flexibility is the hallmark of success in effectively operating in the new, dynamic competitive landscape. Flexibility is an organizational attribute that confers upon the firm the capability to proact or respond quickly and effectively to the changing competitive conditions (Evans, 1982; Hitt, *et. al.*, 1998; Suarez, *et. al.*, 1991; Rindova and Kotha, 2001; Grewal and Tansuhaj, 2001). Organizational flexibility is usually built by developing a flexible resource pool (Cyert and March, 1992; Evans, 1991) and a diverse portfolio of strategic options (Aaker and Mascarenhas, 1984; Bowman and Hurry, 1993). Flexible firms can swiftly redeploy critical resources to in response to emerging business priorities, and leverage the diversity of strategic options available to them to compete effectively (Evans, 1982; Grewal and Tansuhaj, 2001). Organizational flexibility is essentially an adaptive capability that allows a firm to sense and respond to a wide variety of changes in the competitive environment (Volberda, 1996; Shimizu and Hitt, 2004; Rindova and Kotha, 2001; Wigand, 1997). Flexibility means not only just being agile (fast), but also versatile (diverse capabilities) (Evans, 1991; Bahrami, 1992). Therefore, developing a repertoire of flexibility enhancing options is crucial for the competitiveness of high technology firms (Bahrami, 1992).

Organizational flexibility is a multidimensional concept, encompassing agility and versatility, associated with change, innovation, and novelty; coupled with robustness and resilience, implying sustainable advantage and capabilities that may evolve over a period of time (Bahrami, 1992; Volberda, 1996; Volberda, 1997). Since the term 'flexibility' can be variously employed, some authors have suggested that it is best viewed as a family of concepts (Evans, 1991; Genus, 1995). Evans (1991) provided a detailed, historical account of the evolution of research on flexibility and analyzed its various dimensions. He introduced the notions of offensive flexibility and defensive flexibility, and developed an integrative framework for flexibility that incorporates its many dimensions (see Figure 3.1). The term 'flexibility' is not the same as the term 'adaptability'. Adaptability implies a singular and permanent adjustment to the demands of a new environment, whereas flexibility enables a response through successive but temporary approximations to the emergent state of affairs (Genus, 1995).

	Ex-Ante	*Ex-Post*
Offensive	Agility Versatility	Liquidity Elasticity
Defensive	Robustness Hedging	Corrigibility Resilience

Source: Evans (1991)

Figure 3.1: Strategic Flexibility: An Integrative Framework

Chakravarthy (1982) distinguishes between strategies of action that are triggered by changes in the external environment and a "strategy of structure" that focuses on configuration of firm resources for effective response to emergent changes. Flexibility confers upon the firm the adaptive ability to execute the "strategy of structure". In hypercompetitive environments, change cannot be predicted but can only be responded to ex-post (Volberda, 1996), which means flexibility is reactive (Evans, 1991). Hence, a firm's adaptive capability assumes vital importance (Volberda, 1996). Firms operating in fast changing environments have to effectively handle the conflicting forces of change and stability. Indeed, the concept of flexibility is inherently paradoxical: it denotes change as well as preservation (Volberda, 1996). Most definitions of flexibility emphasize adaptive capacity of management in terms of an ability (Aaker and Mascernhas, 1984), a repertoire (Weick, 1982), or a degree of freedom (Sanchez, 1993). Organizational flexibility is not a characteristic of an organization itself; instead, it is a characteristic of relationship between and organization and its environment (Leeuw and Volberda, 1996).

Scholars have examined organizational flexibility in the context of strategic management, organizational design, product development, and manufacturing, and advanced several typologies. Rooted in control systems perspective, Volberda (1996, 2003) has argued that flexibility is essentially a combination of managerial and organizational design tasks. The management task involves developing capabilities and enhancing capacity to speedily and effectively adapt to changes in the environment so as to increase the control capability of the management. The organizational design task involves creating organizational conditions that enhance an organization's adaptability through the repertoire of managerial capabilities (Leeuw and Volberda, 1996; Volberda, 1996; Volberda, 1998). Thus, merely possessing flexibility enhancing capabilities is not enough; effective organization design is necessary to leverage the managerial capabilities (Volberda, 1996).

Researchers have employed real options theoretic lens to examine the value of management flexibility in R&D (Huchzermeier and Loch, 1999; Santiago and Vakili, 2005). Huchzermeier and Loch (1999) explain five types of R&D uncertainty (market payoff, project budget, product performance, market requirements, and project schedule) and discuss sources of flexibility to alleviate them through a bouquet of options (defer/abandon/expand/contract/switch). Scholars have examined issues related to flexibility in product development and the impact of flexibility on development as well as firm performance (e.g., MacCormack and Iansiti, 1997; Thomke, 1997; Thomke and Reinersten, 1998). MacCormack and Iansiti (1997) empirically found that flexibility in product development is positively related to firm performance. Thomke (1997) and Thomke and Reinersten (1998) found that whenever there are changes in technology or user needs or preferences, a flexible product architecture lends itself to reduced cost and time of modifying a design because its elements have less interdependency.

Flexible or modular product and process architectures are key enablers of flexibility in high technology firms (Sanchez and Mahoney, 1996; Worren, *et. al.*, 2002). Flexibility in the context of product competition implies the potential ability of a firm to introduce a greater number of product variations, higher number and frequency of new product introductions, and increased development speed (Worren, *et. al.*, 2002). In the context of product competition, Sanchez and Mahoney (1996) argue that modularity in product and organization design results in flexibility that, in turn, influences organizational learning and knowledge management. Organizational flexibility spawns strategic options through resource flexibility and coordination flexibility (Sanchez, 1995; Sanchez, 1997). Resource flexibility pertains to flexibility inherent in product creating resources, whereas coordination flexibility involves reconfiguring and deploying the resources for new use easily, rapidly, and at low cost. Resource flexibility is higher when a resource can be used for multiple purposes easily and at low switching cost.

Suarez, *et. al.* (1991) identified different kinds of flexibility and analyzed their impact on productivity, quality, and competitive position in the context of manufacturing firms. In a detailed case study of a large telecom service provider in the U.S., Smith and Zeithaml (1996) analyzed the process of capabilities creation and the role of flexibility in improving performance in a hypercompetitive business environment. Similarly, Rindova and Kotha (2001) showed through case studies how organizational form, function and competitive advantage co-evolve in high velocity environments. Finally, organizational flexibility has also drawn the interest of international business scholars. For example, Buckley and Cason (1998) developed a model of multinational enterprises centered on the notion of flexibility. Belderbos and Zhou (2007) adopted a flexibility perspective to analyze employment growth in a large sample of Japanese manufacturing affiliates in 9 Asian countries over a period of time. They found that joint ventures are less flexible when compared to wholly-owned affiliates in dealing with changes in the business environment. Abbott and Banerjee (2003) investigated the impact of organizational flexibility on firm performance in the context of transnational corporations.

An organization seeks flexibility in order to increase the scope and speed of their maneuver (Stuart, 1991). However, excessive flexibility can lead to the organization losing a sense of identity over time (Weick, 1979). Also, flexibility comes in different forms and at different costs (Phillips and Tuladhar, 2000; Suarez, Cusumano, and Fine, 1991). It has also been observed that usually flexibility has been defined very broadly, which makes it difficult to operationalize the concept (Suarez, Cusumano, and Fine, 1991). According to (Phillips and Tuladhar, 2000), flexibility and efficiency can be regarded as antithetical or detrimental to one another.

Several taxonomies have been proposed in the literature on organizational flexibility. For example, based on an analysis of the influence of flexibility on efficiency, quality, and competitive position in the context of manufacturing firms, Suarez, *et. al.* (1991) proposed four types of flexibility:

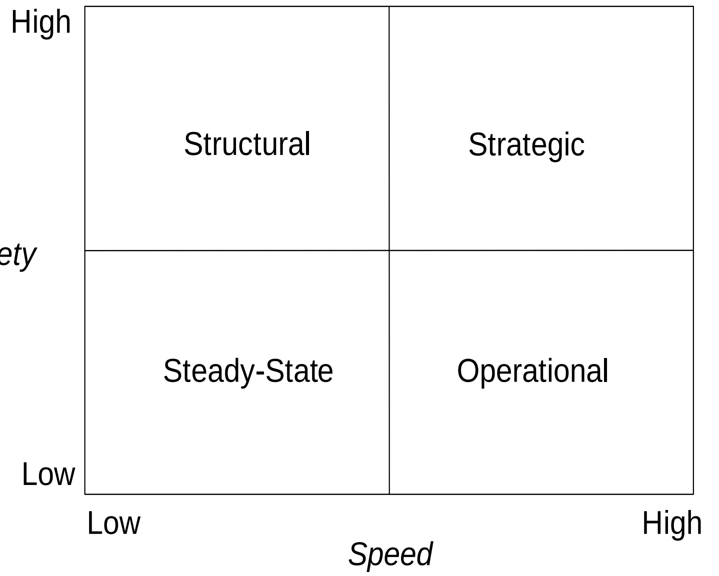
- Mix flexibility—the ability to produce a number of different products at the same time
- New product flexibility—the ability to deal with additions or subtractions from the product mix
- Volume flexibility—the ability to vary volume
- Delivery time flexibility—the ability to reduce time span between order placement and delivery

Abbott and Banerjee (2003) in their study of organizational flexibility and firm performance in the context of transnational corporations (TNC) defined three types of flexibility:

- Market flexibility—the ability of a TNC to quickly recalibrate its marketing efforts to respond to emerging environmental context

- Production flexibility—the ability of the TNC to dynamically organize part of value chain activities at various locations that provide the best cost-value proposition for that particular activity
- Competitive flexibility—the ability to effectively deal with high competitive intensity and technological discontinuity

Volberda (1996, 1998) provides the most exhaustive treatment of organizational flexibility to date. He observes that the managerial capabilities that endow a firm with flexibility essentially represent a hierarchy of capabilities that vary in their degree of contributory potential. Accordingly, Volberda (1996, 1998, and 2003) defines four types of flexibility, as depicted in Figure 3.2: steady-state flexibility, operational flexibility, structural flexibility, and strategic flexibility. In the figure, 'variety' refers to scope and contributory potential of the managerial capabilities, whereas 'speed' refers to the pace with which the necessary capabilities may be executed.



Source: Volberda (1996)

Figure 3.2: Types of Organizational Flexibility

Steady-State Flexibility (low variety, low speed) comprises of static procedures to improve the firm's performance when the levels and nature of throughput are relatively stable over time. It is really not any flexibility because under steady-state conditions there is only minor change and speed of response to external conditions is not paramount (Volberda, 1996, 1998).

Operational Flexibility consists of routine capabilities that are based on the firm's existing structures or objectives. It is the most common type of flexibility and basically pertains to the volume and mix of activities rather than to kinds of activities pursued within the firm. Operational flexibility enables rapid response to changes that are familiar. Typically, such changes cause temporary, short-lived fluctuations in the activities of the firm. Operational flexibility enables accelerated response to emergent but familiar situations, but does not involve a great deal of variety (Volberda, 1996, 1998).

Structural Flexibility corresponds to the ability of the management to adapt the organization structure as well as the decision and communication processes of the firm to the changing conditions of the environment. Structural flexibility can be internal or external. Internal structural flexibility involves intra-organizational leeway to renew or transform the existing structures and processes. External structural flexibility leverages inter-organizational arrangements to develop new technologies, products, or markets. Structural flexibility provides high variety but low speed of response (Volberda, 1996, 1998).

Strategic Flexibility refers to the managerial capabilities that enable an organization to adapt when the changes in the environment are substantial, unfamiliar, and fast occurring, with far reaching consequences for the organization. Usually, strategic flexibility involves changes in the nature of organizational activities. The repertoire of strategic flexibility options offers high speed and variety, which is necessary to achieve congruence with fast-paced, dynamic environments (Volberda, 1996, 1998).

Volberda (1996; 1998) makes a further distinction between internal and external flexibility. Internal flexibility pertains to management's capability to adapt to the demands of the environment, whereas external flexibility refers to management's capability to influence the environment (Volberda, 1996; 1998). Thus, operational flexibility, structural flexibility, and strategic flexibility can be internal or external (Volberda, 1996; 1998). Table 1 shows examples of various types of internal and external organizational flexibility.

3.2.1 Enablers and Inhibitors of Organizational Flexibility

A number of authors have examined the factors that enable or inhibit flexibility in organizations (e.g., Evans, 1982, 1991; Sanchez, 1995; Schilling and Steensma, 2001). A major research stream in the organizational flexibility literature deals with organizational forms. An organization form is a management tool that is used to achieve an optimal alignment between the organization and the environment (Lewin, *et. al.*, 1999).

Table 3.1 Examples of Internal and External Types of Flexibility
Source: Volberda (1998:118)

	Internal	External
Routine Maneuvering Capacity	*Internal Operational Flexibility* Variation of production volume Building up of inventories Use of crash teams	*External Operational Flexibility* Use of temporary labor Multi-sourcing Reserving of capacity with suppliers
Adaptive Maneuvering Capacity	*Internal Structural Flexibility* Creating multi-functional teams Changing managerial roles Alterations in control systems	*External Structural Flexibility* Purchasing of components from suppliers with a short delivery time (JIT) Purchasing of sub-assemblies from suppliers Co-design—developing components with suppliers
Strategic Maneuvering Capacity	*Internal Strategic Flexibility* Dismantling of current strategy Applying new technologies Fundamentally renewing products	*External Strategic Flexibility* Creating new product-market combinations Using market powers to deter entry and control competitors Engaging in political activities to counteract trade regulations

It is well established that a mechanistic structure inhibits flexibility, whereas an organic structure enables flexibility (Burns and Stalker, 1961; Volberda 1996). Volberda (1996, 1998) investigated how the functional, divisional, matrix and innovative organizational forms influence operational, structural, and strategic flexibility in a firm. Research shows that when organizational structures are characterized by high centralization and formalization, the potential for flexibility is low (Volberda, 1996; Volberda, 1998; Volberda, 2003). On the other hand, modular organizational forms such as networked organization, virtual organization, platform organization, which are characterized by a loosely coupled structure, promise high flexibility potential (Volberda, 1996, 1998, 2003).

Modular organizations allow organizational components to be flexibly and quickly recombined into a variety of configurations and thereby enable organizational flexibility (Schilling and Steensma, 2001). Empirical research on organizational flexibility shows that alliances and outsourcing arrangements help address rapid product development life cycles, reduce risk, and provide flexibility, while also bringing in complementary capabilities (Evans, 1982; Schilling and Steensma, 2001; Sanchez, 1995; Sanchez, 1997; Bahrami, 1992; Hitt, *et. al.*, 1998). Scholars have suggested that achieving optimal balance between internal and external R&D and creating mechanisms to acquire new ideas and perspectives from outside the firm can be gainful for organizational flexibility (Evans, 1982; Shimizu and Hitt, 2004). According to Evans (1982), resource mobility enhances flexibility since it enables access to new knowledge. Thus, globally distributed R&D network can be a source of flexibility since they facilitate transfer and cross-pollination of new ideas and promote organizational learning.

Slack is another major source of organizational flexibility because in situations of high uncertainty it serves as a buffer between the organization and environmental discontinuities (Evans, 1991), and provides the organization with the exploratory capacity essential for innovation (Leonard, *et. al.,* 2003). Organizational learning that facilitates building-up of dynamic core competences also endows a firm with flexibility (Hitt, *et. al.*, 1998). Access to versatile skill pool also generates organizational flexibility (Evans, 1982; Volberda, 1996). In addition, the capability to efficiently and rapidly reconfigure and redeploy resources is an important determinant of organizational flexibility (Evans, 1982). Moreover, systematically rotating managers in key positions may enhance organizational flexibility (Shimizu and Hitt, 2004). An adaptive organizational culture also inculcates flexibility (Volberda, 1998). Organizational inertia, resistance to change, and what Leonard (1995) has described as the ‘familiarity trap’ (Leonard, 1995) inhibit organizational flexibility **(**Shimizu and Hitt, 2004). Volberda (1998) has argued that high degree of socialization is negatively related to flexibility, although Liebeskind, *et. al.* (1996) in their empirical study of biotechnology industry found that strong social networks positively impacted flexibility.

Organizational flexibility and innovative capability are interrelated (Volberda, 1998; Verdu-Jover, *et. al.*, 2005). Innovation is the primary way in which organizations adapt to the changing business environment (Dougherty, 1992; Lam, 2005). Thus, an organization’s innovative capability must enable it to adapt effectively to the demands of its environment. However, a firm’s innovative capability itself is reinforced by the repertoire of flexibility enhancing options (flexible organizational forms, organizational slack, adaptive culture, etc.) that it possesses. Loosely coupled, heterogeneous organizations enable radical innovative capability but inhibit incremental innovative capability. On the other hand, tightly coupled, highly centralized and formalized, homogenous organizations facilitate incremental innovative capability (Weick, 1982; Volberda, 1998). Firms need a strong repertoire of operational, structural, and strategic flexibility in order to simultaneously pursue both incremental and radical innovative capability, and thus improve its adaptive capability (Verdu-Jover, *et. al.*, 2005). Flexibility enables an organization to modify or abandon the established routines and rapidly develop new ones, so that continuous and effective adaptation to the environment happens. Seen from this perspective, flexibility is an integral component of a firm's dynamic capability (Wang and Ahmed, 2007).

3.3 DYNAMIC CAPABILITIES

The resource based view of the firm posits that the heterogeneity of resource endowments across firms is the source of their differential performance (Penrose, 1995; Barney, 1991; Peteraf, 1993). Strategic management scholars have argued that tangible and intangible resources that are valuable, rare, inimitable, non-substitutable, and immobile confer sustainable competitive advantage to a firm (Barney, 1991; Peteraf, 1993). Firm resources can be tangible and intangible, and include all assets, capabilities, organizational processes, relationships, and knowledge owned or controlled by a firm (Wernerfelt, 1984; Collins, 1991; Tyler, 2001). However, it is not so much the resources per se but the services rendered by the resources that are important to a firm (Penrose, 1959). Capabilities are special types of resources that denote the firm's capacity to productively deploy its resources to achieve a desired end (Amit and Schoemaker, 1993; Dutta, *et. al.*, 2005).

Capabilities are firm specific because they develop over time through complex interactions among the firm's resources and are embedded in the organization and its processes. Unlike resources, which can be traded in the factor markets, capabilities cannot be easily traded or transferred due to their embeddedness (Amit and Schoemaker, 1993; Kogut and Zander, 1992). Capabilities are essentially organizational routines (1991). Strategic assets are difficult to trade and imitate scarce, appropriable and specialized resources and capabilities that are at the core of the firm's competitive advantage. Intangible or tacit assets are the most potent of all assets (Prahalad and Hamel, 1990; Nelson and Winter, 1982; Grant, 1996a). Firms are idiosyncratic because they make irreversible investments to accumulate resources through time-consuming processes (Dierickx and Cool, 1989). Firms with broad resource base tend to pursue diversification (Penrose, 1959).

However, the notion of sustainable competitive advantage rooted in the resources and capabilities perspective suffers from two major shortcomings. First, the resource based view is static in its orientation because it does not account for the influence of market dynamism on the firm's competitive advantage (Teece and Pisano, 1994; Teece, *et. al.,* 1997; Eisenhardt and Martin, 2000). It assumes permanency of resources' attributes (valuable, rare, inimitable, and non-substitutable) that generate competitive advantage (Wang and Ahmed, 2007). However, in highly dynamic business environments, achieving sustainable competitive advantage may not be possible (Eisenhardt and Martin, 2000). Second, the resource based view does not illuminate on how the resources are actually transformed to derive competitive advantage (Priem and Butler, 2001a, 2001b; Eisenhardt and Martin, 2000). Competitive success in highly dynamic global business environment demands timely responsiveness, fast and flexible product innovation, and the organizational capability to effectively coordinate and redeploy internal and external competencies (Teece, *et. al.*, 1997).

The dynamic capabilities perspective extends the resource based view by encapsulating the influence of market dynamism on a firm's competitive position and the evolutionary nature of resources and capabilities (Teece, *et. al.*, 1997; Eisenhardt and Martin, 2000; Wang and Ahmed, 2007). The term 'dynamic' refers to the ability of a firm to renew its competences so as to achieve congruence with the changing business environment. The term 'capabilities' underscores the strategic role of the management in effectively adapting, integrating and reconfiguring internal and external resources, skills and competences to match the demands of a dynamic environment (Teece, *et. al.*, 1997). Dynamic capabilities are organizational processes that use resources and confer upon the firm the ability to integrate, build, and reconfigure internal and external resources and competences to create new productive assets in congruence with changing markets (Teece, *et. al.*, 1997; Eisenhardt and Martin, 2000). Thus, dynamic capabilities reflect an organization's ability to effectively configure its resources in alignment with market dynamics to achieve new and innovative forms of competitive advantage (Teece, *et. al.*, 1997; Eisenhardt and Martin, 2000).

According to Zollo and Winter (2002), a dynamic capability is a learned and stable pattern of collective activity through which the organization systematically creates new operating routines in pursuit of improved effectiveness and modifies them to match the demands of its environment. They argue that dynamic capabilities are shaped by the co-evolution of tacit experience accumulation, and explicit knowledge articulation and knowledge codification processes. Dynamic capabilities include the abilities to learn, solve problems, and identify new problems to solve (Dosi and Marengo, 1994; Madhok and Osegowitsch, 2000). Some dynamic capabilities integrate resources (e.g., product development), some focus on reconfiguration of resources (e.g., knowledge transfer/integration), whereas some dynamic capabilities are related to access, accumulation, and divesting of resources (e.g., new knowledge creation) (Eisenhardt and Martin, 2000). Specific and identifiable processes such as product development, strategic decision-making, and strategic alliances are dynamic capabilities (Eisenhardt and Martin, 2000). However, the value of dynamic capabilities lies in the resource configurations that they generate, and not in the capabilities themselves (Eisenhardt and Martin, 2000).

Organizational capabilities, when deployed effectively to achieve a desired goal, have the potential to result in improved performance. In that sense, organizational capabilities are "first-order" capabilities. Core capabilities are a specific subset of firm resources and capabilities that are of strategic importance for competitive advantage at a given point in time. However, core capabilities can become "core rigidities", or become strategically irrelevant in the face of major environmental disruption (Leonard-Barton, 1992). Therefore, core capabilities are "second-order" capabilities. Dynamic capabilities signify constant pursuit of renewal and reconfiguration of resources and capabilities to achieve alignment with the rapidly changing environment. Hence, dynamics capabilities are "third-order" capabilities, and essentially govern the rate of change of organizational capabilities (Collis, 1994; Winter, 2003; Wang and Ahmed, 2007). Dynamic capabilities are the ultimate organizational capabilities that shape a firm's long-term performance. However, in order to derive competitive advantage by leveraging dynamic capabilities, they must be deployed "sooner, more astutely, and more fortuitously" to create valuable resource configuration (Eisenhardt and Martin, 2000).

Even though dynamic capabilities are idiosyncratic in their details and path-dependent in their emergence, they share commonalities among firms (Eisenhardt and Martin, 2000). Wang and Ahmed (2007) identify adaptive capability, innovative capability, and absorptive capability as the three component factors that reflect the common features of dynamic capabilities. Adaptive capability is manifested through the inherent flexibility of firm resources as well as the flexibility in deploying these resources (Sanchez, 1995). Innovative capability refers to a firm's ability to develop new product, services and markets (Schumpeter, 1983). Absorptive capability refers to the ability of the firm to absorb and assimilate valuable information from its external environment (Cohen and Levinthal, 1990). According to Wang and Ahmed (2007), adaptive capability, innovative capability, and absorptive capability underpin a firm's ability to accumulate, integrate, reconfigure, and renew its resources and capabilities in alignment with its external environment. Cooperative competencies (information management and relationship management) are complementary to technical and functional competences needed for innovation. Cooperative competencies enable intra- and inter-firm tacit knowledge sharing and knowledge transformation (Tyler, 2001), and hence are an integral element of a firm's dynamic capabilities.

The dynamic capabilities perspective is an efficiency-based approach for firm performance, and is especially relevant in Schumpeterian environments where time-to-market is critical, the rate of technological change is rapid, and the nature of future competition and market evolution difficult to comprehend (Teece, *et. al.*, 1997). The dynamic capabilities perspective regards the firm as a repository of knowledge, which accumulates in an incremental and path-dependent manner. Effective knowledge creation and integration underpins a firm's innovative capability, and hence its dynamic capabilities (Madhok and Osegowitsch, 2000; Teece, *et. al.*, 1997). In moderately dynamic markets, changes occur frequently but along predictable paths, and the industry structures are relatively stable. In such markets, usually the existing knowledge serves as the source of effective dynamic capabilities, and managerial actions follow a problem-solving approach. In contrast, in highly dynamic markets, the course of change is nonlinear and unpredictable, markets are characterized by continuous flux, and industry structures are ambiguous. In these markets, the focus of a firm's dynamic capabilities is to on rapidly creating situation-specific new knowledge (Eisenhardt and Martin, 2000).

The notion of dynamic capabilities has semblance with what Kogut and Zander (1992) have termed as 'combinative capabilities', or Henderson and Cockburn (1994) refer to as 'architectural competence'. According to Henderson and Cockburn (1994), two broad classes of capability, namely component competence and architectural competence, serve as sources of firm competitive advantage. Component competence refers to the local abilities and knowledge that are fundamental to routine problem solving. Architectural competence refers to the ability to integrate the component competencies effectively and to develop new component competencies. Coordination, integration, learning and transformation are the fundamental elements of dynamic capabilities. R&D capabilities are the leading source of dynamic capabilities in high technology firms (Nelson, 1991). Investments in dynamic capabilities can serve as hedge against obsolescence of existing capabilities. However, a long-term commitment to specialized resources is necessary for developing dynamic capabilities (Winter, 2003).

Dynamic capabilities are higher order processes embedded in the organization (Eisenhardt and Martin, 2000). The dynamic capabilities perspective has been applied to firm research and development (Nelson and Winter, 1982) and is particularly relevant for examining aspects related to the competitiveness of high technology firms (Teece, *et. al.*, 1997; Eisenhardt and Martin, 2000). Moreover, the focal constructs of this study, namely innovative capability and organizational flexibility, are integral components of dynamic capabilities of the firm (Wang and Ahmed, 2007). Therefore, the dynamic capabilities perspective is an appropriate theoretical lens for this study.

3.4 AGENCY THEORY

Agency theory, originally developed in the financial economics literature (Jensen and Meckling, 1976), is an empirically valid framework (Eisenhardt, 1989a) that has been employed extensively in strategic management and organizational research (Eisenhardt, 1989a; Rumelt, *et. al.,* 1991; Hoskisson, *et. al.,* 1999). Scholars have applied agency theory to many substantive topics such as innovation, corporate governance, and organizational behavior (Eisenhardt, 1989; Hoskisson, *et. al.,* 1999). Agency theory concerns design of optimal contracts and incentive structures, allocation of decision rights, and use of control mechanisms to minimize conflicting goals and interests between two parties in an exchange relationship (Jensen and Meckling, 1976; Fama and Jensen, 1983; Eisenhardt, 1989a; Rumelt, *et. al.*, 1991; Hoskisson, *et. al.*, 1999). Eisenhardt (1989a) observes that incorporating an agency perspective in studying phenomena that involve a cooperative structure can be valuable.

An agency structure exists whenever one party delegates work and related decision-making authority to a second party in an exchange relationship. The party delegating work and decision-making rights is the *principal*, and the party to whom the work and decision-making authority is delegated is the *agent* (Jensen and Meckling, 1976; Eisenhardt, 1989a). Understandably, in such an exchange relationship, the welfare of the principal is affected by the actions and choices of the agent (Ross, 1973; Arrow, 1985). An agency problem arises when the principal and agent have conflicting goals and different attitude towards risk (Eisenhardt, 1989a). Agency theory assumes that human beings are boundedly rational, self-interested, and opportunistic. Hence, in an exchange relationship, the agent will likely seek to maximize his/her own interests even at the expense of the principal (Eisenhardt, 1989a). The agency problem becomes particularly acute when the principal cannot verify whether the agent's actions and behaviors are supportive of his/her interests (Ross, 1973; Eisenhardt, 1989a). The basic unit of analysis in agency theory is the contract governing the relationship between the principal and the agent (Eisenhardt, 1989a; Hoskisson, *et. al.*, 1999).

Rooted in information economics, especially transaction cost economics and property rights literature (Eisenhardt, 1989a; Hoskisson, *et. al.*, 1999), agency theory has developed in two branches: Positivist Agency Theory and Principal-Agent Research (Eisenhardt, 1989a; Rumelt, *et. al.*, 1991). The positivist agency theory, also known as corporate control branch of the agency theory, deals with agency problems ('bad' management) associated with corporate governance. The theory posits that the separation of ownership and control between shareholders (principals) and managers (agents) often leads to divergence of goals, with managers seeking to maximize their own gain at the expense of shareholders' interest (Jensen and Meckling, 1976; Arrow, 1985; Rumelt, *et. al.*, 1991; Eisenhardt, 1989a). The focus of the positivist agency theory is on crafting suitable governance mechanisms to arrest the agent's self-serving behaviors by accounting for scenarios in which the principal and agent are likely to have divergent goals (Jensen and Meckling, 1976; Fama, 1980; Eisenhardt, 1989a). Research suggests that outcome-based contracts are an effective means to alleviate the agency problem because they help curb opportunism and align goals of the principal and agent since their rewards depend on the same actions (Jensen and Meckling, 1976; Fama, 1980; Arrow, 1985; Eisenhardt, 1989a).

The principal-agent branch of the agency theory is concerned with principal-agent relationship in general, and is applicable to a range of relationships such as employer-employee, buyer-supplier, headquarters-subsidiary, etc. (Eisenhardt, 1989a). The main focus of the principal-agent relationship branch is on determination of an optimal (i.e., most efficient) contract between the principal and agent under varying levels of outcome uncertainty, risk aversion, and information availability (Eisenhardt, 1989a; Rumelt, *et. al.*, 1991). The agency problem may arise (a) when the principal and agent have different goals and (b) when the principal cannot establish that the agent's actions and behaviors are in the principal's best interest (Jensen and Meckling, 1976; Eisenhardt, 1989a). The literature on agency theory points to two specific challenges that the principal faces in a principal-agent relationship: 'moral hazard' and 'adverse selection'. Both moral hazards and adverse selection accentuate the agency problem. The moral hazard issue arises due to lack of the required effort on the part of the agent. For example, the agent, while being paid for one project, might be working on another project. The adverse selection problem arises when the agent misrepresents its abilities and the principal cannot verify the agent's abilities before entering into the exchange relationship (Eisenhardt, 1989a).

In order to address the agency problem in a principal-agent relationship, either an outcome-based contract or a behavior-based contract may be employed, depending on the ease with which the principal (a) can specify and measure the output and (b) verify the agent's behaviors and actions (Arrow, 1985; Eisenhardt, 1989a). When there is a likelihood of goal conflict between the principal and the agent, or when the output can be accurately specified and measured in advance, an outcome-based contract is effective. When appropriate behavior by the agent can be specified in advance, i.e., task programmability, behavior-based contracts are appropriate. When a behavior-based contract is used, investment in information systems or monitoring mechanisms such as reporting procedures, structured and regular performance reviews and effective oversight are helpful in dealing with the agency problem since they reveal the agent's actions and behaviors to the principal (Jensen and Meckling, 1976; Arrow, 1985; Eisenhardt, 1989a).

The cost associated with verifying the agent's behavior and actions is an important consideration in choosing the type of contract (Jensen and Meckling, 1976; Eisenhardt, 1989a). Like the principal, an agent can also invest in bonding mechanisms to reassure the principal that his/her actions and behaviors are in the best interest of the principal (Jensen and Meckling, 1976). Both monitoring and bonding incur costs, known as the agency costs (Jensen and Meckling, 1976), and hence parties in an exchange need to determine the extent of their respective investments in developing monitoring and bonding mechanisms. In a principal-agent relationship, the principal may also incur some residual cost that arises due to insufficiency of monitoring and bonding mechanisms (Jensen and Meckling, 1976), and hence existence of the agency problem to some extent. Thus, total agency cost includes monitoring cost, bonding cost, and residual cost. In an outcome-based contract, the risk is transferred to the agent and due to this, the agent may demand a premium for the rendering the services under the exchange (Eisenhardt, 1989a; Arrow, 1985).

Incorporating the principal-agent relationship perspective is considered useful for studying organizational phenomena that involve cooperative structures (Eisenhardt, 1989a). The literature on globalization of R&D and multinational management suggests that scholars tend to view the headquarters–subsidiary relationship as a principal– agent relationship (Bjorkman, Barner-Rasmussen, and Li, 2004). Given that this research focuses on a phenomenon that involves a cooperative structure, the principal-agent theory promises to be a useful framework for modeling the relationship between the firm and its offshore R&D organization.

3.5 SUMMARY

The purpose of this chapter was to build on insights and gaps surfaced by Chapter 2, and discern theoretical underpinnings that can guide the present inquiry. Towards that, this chapter explicated the concepts of innovative capability and organizational flexibility that form the focus of this study. The innovation literature suggests that a firm's innovative capability depends on (a) the structural characteristics of the organization, (b) organizational processes that facilitate creation, transfer and integration of knowledge, and (c) attributes of the organization. Also, whilst knowledge combination or integration does not necessarily assume knowledge transfer, the literature highlights that knowledge transfer is important for the innovative capability of a firm. Organizational flexibility, on the other hand, is the adaptive capacity that arises from the flexibility of a firm's resources and management processes deployed to manage the resources. Both innovative capability and organizational flexibility are key dynamic capabilities of the firm. The review of agency theory in this chapter also suggested the usefulness of the principal-agent relationship for the present research.

However, it is important to note that the discussions on innovative capability and organizational flexibility in the literature have largely been in the context of unitary organizations. While scholarly discourse linking R&D globalization and organizational flexibility is absent, as shown in Chapter 2, a few scholars have examined aspects related to innovative capability in the context of globalization of R&D. However, as discussed earlier, the economic and structural characteristics underlying offshoring of R&D do not fully correspond with the traditional market or technology seeking globalization of R&D. The next chapter, therefore, considers the theoretical underpinnings from this chapter along with the insights contributed by Chapter 2 and juxtaposes them to develop a conceptual lens for the empirical inquiry.

CHAPTER 4
CONCEPTUAL LENS

CHAPTER 2 PROVIDED a review of the extant literature on globalization of R&D, whereas in Chapter 3 the focus was on explicating theoretical elements that are relevant for this study. The purpose of this chapter is to draw on the insights derived from the literature review (Chapter 2) and leverage the theoretical underpinnings identified in the previous chapter (Chapter 3) to develop a conceptual lens that can guide the empirical inquiry. The conceptual lens developed in this chapter seeks to illuminate on the link between offshoring of R&D and a firm's innovative capability and organizational flexibility. The purpose of the conceptual lens is not to develop propositions or assertions typical of research frameworks. Instead, the conceptual lens is meant to equip the researcher with the ability to understand and analyze the focal aspects of the phenomenon comprehensively. Seen in that perspective, the conceptual lens is akin to “walking sticks” or “scaffolding” (Roethlisberger, 1977; Walsham, 1995, 2006; Silverman, 2000).

In what follows, first an overview of the conceptual lens is presented along with brief descriptions of the key concepts in Table 4.1. This is followed by a step-by-step explanation of how the conceptual lens was developed (Section 4.3). The chapter concludes with an integrative perspective on offshoring of R&D, firm innovative capability and organizational flexibility.

4.1 CONCEPTUAL LENS

Figure 4.1 shows the conceptual lens for the inquiry. As depicted, offshoring of R&D is enacted as an engagement between two parties, usually the firm's headquarters and an offshore R&D unit, which performs R&D activities on behalf of the firm headquarters. In this research, the engagement between the firm's headquarters and offshore R&D unit is modeled as a principal-agent relationship, where the firm headquarters is the principal and the offshore R&D unit is the agent (Eisenhardt, 1989a; Nohria and Ghoshal, 1997). An offshore R&D organization (the agent) may either be the firm's own subsidiary or a different firm altogether. The main motivation for the firm headquarters (the principal) in offshoring R&D activities is to access knowledge resources at low cost structures in order to improve its R&D efficiency (UNCTAD, 2004b, 2005; Cohen, 2007, Mudambi, 2007).

As the conceptual lens shows, there are three key organization and management processes associated with offshoring of R&D—allocation of R&D tasks to the offshore R&D unit, determination of integration mechanisms for coordination of offshore R&D

work, and knowledge transfer from the offshore R&D unit to the firm headquarters. The principal determines the R&D activities to be performed offshore in accordance with its business needs and allocates R&D tasks to the agent. The allocation of R&D tasks to the agent is expected to be based on the agent's stock of skills and knowledge. The agent's stock of skills and knowledge may be similar to that of the principal (duplicated knowledge) or different from the principal (diverse and complementary knowledge) (Zander, 1999).

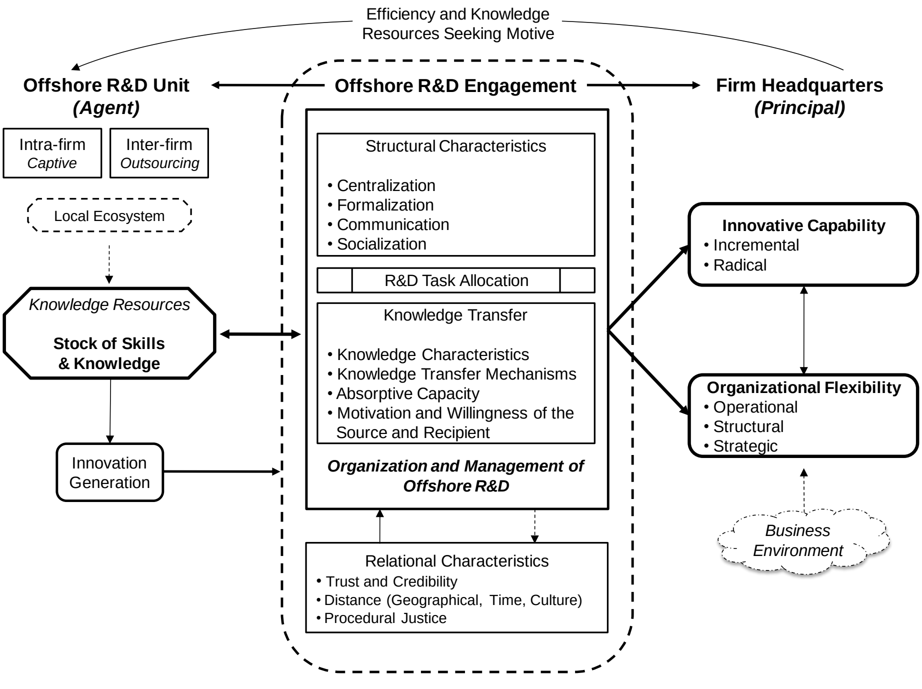


Figure 4.1: Conceptual Lens for the Study

The principal may either specify the R&D outputs to be produced by the agent or tightly control its R&D activities to ensure that the agent's efforts are aligned with the principal's objectives (Eisenhardt, 1989a). In order to coordinate and integrate the activities of the agent, the principal employs a set of formal and informal coordination mechanisms (Martinez and Jarillo, 1991). Accordingly, this research considers four complementary mechanisms as useful for coordination of offshore R&D engagements: centralization, formalization, communication, and socialization (Ghoshal and Bartlett, 1988; Nohria and Ghoshal, 1997; Nobel and Birkinshaw, 1998). These coordination mechanisms together provide a fairly comprehensive and complementary coordination capability to the principal (Nohria and Ghoshal, 1997; Nobel and Birkinshaw, 1998).

The principal-agent relationship structure along with the coordination mechanisms defines the structural characteristics of an offshore R&D engagement.

An agent may contribute to the principal's innovative capability in two different ways: (a) by producing innovative outputs and (b) through the process of knowledge transfer (Venaik, *et. al.*, 2005). The agent's ability to create new knowledge and generate innovative outputs depends not only on its existing stock of knowledge but also on the engagement's structural characteristics (Ghoshal and Bartlett, 1988; Persaud, 2005). Specifically, whilst each of the four coordination mechanisms mentioned above complement each other, they also compete with each other in the sense that each impacts the agent's ability to innovate differently. Also, when the principal allocates R&D tasks to an agent, it essentially determines the scope of the agent's innovative activity and thereby affects the agent's opportunity to generate innovative outputs. The structural characteristics of the offshore R&D engagement are also expected to influence the process of knowledge transfer from an agent to the principal (Foss and Pedersen, 2002, 2004). In addition, transfer of knowledge from an agent to the principal is determined by the characteristics of knowledge (codified versus tacit), absorptive capacity of the principal, motivational dispositions of both the agent and principal, and the effectiveness of the mechanisms deployed for knowledge transfer (Szulanski, 1996; Gupta and Govindarajan, 2000).

The low cost structure of the agent's R&D resources may potentially endow the principal with the ability to access and/or accumulate a large number of R&D resources with versatile and diverse skills at the agent site. The principal may also maintain slack R&D resources at the agent organization at low costs. This, in turn, may permit the principal to flexibly reconfigure and redeploy R&D resources to address fluctuations in the market demand, or to develop a repertoire of flexible response options at low cost, to enhance its adaptive capacity (Volberda, 1996; Sanchez, 1995, 1997).

Finally, the characteristics of the relationship between the principal and agent influence the organization and management processes. Trustworthiness and credibility of the agent in the perception of the principal may not only influence R&D task allocation but also impact the process of knowledge transfer. Distance hampers flow and frequency of communication and causes difficulty in R&D task coordination. Accordingly, the distance (geographical, time zone, and cultural) between the principal and agent may influence the choice of coordination mechanisms, the process of knowledge transfer, and R&D task allocation.

Table 4.1 captures the key concepts shown in the conceptual lens and describes how they are observed in this study during the empirical inquiry.

Table 4.1: Key Concepts, their Definitions and Observation

Concept	Definition/Description	How the Concept is Observed
Offshore R&D Engagement	A dyadic exchange relationship between two parties—modeled as principal-agent relationship—in which the agent (Offshore R&D Unit) located in a low-cost country performs R&D activities on behalf of the principal (Firm Headquarters)	Whether the agent is a subsidiary of the firm or a different company altogether (intra-firm versus inter-firm offshoring of R&D); motive of the principal in offshoring R&D; number of R&D staff at the offshore R&D unit; tenure of the offshore R&D engagement
Stock of Skills and Knowledge	Refers to the value and types of technical skills and knowledge at an offshore R&D unit	Differences in stocks of technical skills and knowledge between the two locations—whether the agent's stock of skills and knowledge is similar to (duplicated), different from (diverse), or complementary to the principal's stock of skill and knowledge; concentration of specific technical skills and knowledge at the offshore R&D unit; existence of centers of excellence (competence) in specific technical areas at the offshore R&D unit
Knowledge Resources	Refers to volume/scale of technical R&D human resources at an offshore R&D unit	Size of the agent's R&D resource base; availability of slack R&D resources with the agent
R&D Task Allocation	Refers to allocation of specific R&D tasks by the principal to agent	Type of R&D tasks allocated (research or development) to the agent; criteria and practices for R&D task allocation to the agent

Concept	**Definition/Description**	**How the Concept is Observed**
Structural Characteristics	Refers to the characteristics of organizational structure that governs an offshore R&D engagement—the principal-agent relationship together with mechanisms used to coordinate offshore R&D activities define the structural characteristics	Type of control exercised by the principal—whether the principal (a) clearly specifies and measures R&D outcomes to be produced by the agent or (b) tightly manages the agent's R&D tasks and processes; also, how the principal coordinates offshore R&D activities
Centralization	Refers to the extent to which an agent has relative influence on decisions that concern R&D activities for which the agent is responsible	Who makes the following types of decisions: (a) allocation of R&D tasks to the agent, (b) the agent's budget and resource levels, (c) Priorities and schedules for the R&D activities the agent is responsible for, (d) new R&D programs (e) enhancement or modifications to existing products and R&D processes
Formalization	Refers to the extent of use of formal plans, written procedures and formal reviews by a principal to coordinate offshore R&D activities	Whether documented plans, R&D procedures, and formal reporting procedures exist and are being used.
Communication	Refers to formal and informal exchange of information between principal and agent	Type and contents of communication; frequency and density of communication between the principal and agent
Socialization	Refers to extent of social interactions between principal and agent aimed at developing interpersonal ties to build a shared set of values, objectives, and behavioral norms across two locations	Frequency and volume of visitors between the two locations; exchange of R&D staff; job rotation programs; cross-location committees and task forces

Concept	Definition/Description	How the Concept is Observed
Relational Characteristics	Refers to the characteristics of relationship between principal and agent	Relational quality based on existence of trust, mutual respect, fairness, social interactions, and how distance affects the relationship
Trust	Refers to the extent to which principal and agent trust each other and believe that each party will act to advance the best interests of the other party	Experiences of the principal and agent with each other; the principal and agent's level of mutual respect for each other; the principal's perception of agent's integrity, and vice versa; the principal's attitude towards agent
Credibility (of the Offshore R&D Unit)	Refers to the extent of principal's confidence in an agent's ability to deliver on assigned objectives	Level of the principal's confidence in the agent's ability; the principal's perception of the agent's demonstrated technical contributions; evolution in the agent's R&D responsibility/scope over time; the principal's propensity to entrust high-risk work to the agent; predictability of the agent's performance
Distance	Refers to physical/geographical, time zone, and cultural distance between principal and agent	Involvement of actors from two different countries implies physical distance; the differences in time zones and overlap of working hours between the two locations; language differences between the two locations; impact of the differences arising from distance on organization and management of offshore R&D

Concept	Definition/Description	How the Concept is Observed
Procedural Justice	Refers to the extent to which an agent considers the dynamics of principal's decision-making processes pertaining to offshoring of R&D to be fair	The ability of the agent to participate in strategy-making process for offshoring of R&D; the ability of the agent to legitimately challenge the principal's views; the extent to which the agent is given an account of the principal's decisions as they relate to offshoring of R&D; consistency of the principal's decisions that affect the agent
Knowledge Transfer	Refers to the process of knowledge transfer from agent to principal	Whether knowledge transfer is an explicit and important goal
Knowledge Characteristics	Refers to whether the knowledge created by an agent is explicit, codified, or tacit	Types and contents of knowledge transferred from the agent to the principal; the mechanisms used for knowledge transfer
Knowledge Transfer Mechanisms	Refers to formal and informal mechanisms deployed to transfer knowledge from agent to principal	Whether the transfer of knowledge occurring through documentation, embeddedness in products, informal interactions, cross-location groups and task forces, meetings, emails, electronic infrastructure, etc.
Absorptive Capacity	Refers to the ability of principal to recognize, value, transfer and integrate knowledge from an agent	The principal's prior related experience/knowledge in the technical areas in which the agent performs R&D; whether the principal worked in the same technical areas before

Concept	Definition/Description	How the Concept is Observed
Motivation and Willingness of the Source of Knowledge	Refers to an agent's inclination to transfer its knowledge to principal	The agent's perception of procedural justice; the agent's need to establish its superiority and attain power through its stock of knowledge
Motivation and Willingness of the Recipient of Knowledge	Refers to principal's inclination to engage in the process of transferring knowledge from an agent	Knowledge stock differential between the principal and agent; relevance and appeal of the agent's knowledge in the perception of the principal; existence of NIH syndrome at the firm headquarters
Innovative Capability	Refers to the ability of principal to create innovative outputs (products, processes, and technologies)	Number of innovations produced; type of innovative outcome (product, process, or technology); nature of innovations (incremental/radical); impact of offshoring of R&D on innovation speed; availability of slack resources at the agent organization
Incremental Innovative Capability	Refers to the ability of principal to create incremental innovations (products, processes, and technologies)	Volume (number) and variety (types) of incremental innovations produced in a given time period
Radical Innovative Capability	Refers to the ability of principal to create radical innovations (products, processes, and technologies)	Volume (number) and variety (types) of radical innovations produced in a given time period
Organizational Flexibility	Refers to principal's adaptive capacity, i.e., the ability to reconfigure and redeploy its resources to respond to changes in the business environment	Number and type of flexible response options configured and deployed by the principal by leveraging the agent's R&D resources; availability of slack resources at the agent organization

Concept	Definition/Description	How the Concept is Observed
Operational Flexibility	Refers to principal's ability to change the volume and mix of its R&D activities to respond to familiar changes in its business environment	Leveraging of the agent's resources to staff R&D projects to address emergent market requirements; easy ramp-up/down of R&D resources in accordance with business need
Structural Flexibility	Refers to the ability of principal to change its organizational structure to adapt to changes in its business environment	Creation of cross-functional teams by the principal by leveraging the agent's R&D resources to address environmental changes; sourcing components from agents; co-design of products with the agent; leveraging the agent's R&D resources to pursue different type of innovative activity
Strategic Flexibility	Refers to the ability of principal to adapt itself to fundamental and fast-occurring changes in its environment	Leveraging agent's R&D resources to apply new technologies, fundamentally renew products, and create new product-market combinations

4.2 DEVELOPING THE CONCEPTUAL LENS

This section explains step-by-step development of the conceptual lens for the empirical inquiry. Specifically, drawing on the literature review and theoretical underpinnings, this section develops a conceptual understanding of how offshoring of R&D links with a firm's innovative capability and organizational flexibility.

4.2.1 Offshore R&D Engagement

Offshoring of R&D is essentially a globally distributed exchange relationship in which one party located in a low-cost country—referred to as 'Offshore R&D' unit in this research— performs R&D activities for another party in a different country—referred to as 'Firm Headquarters' in this research. Such an exchange relationship is referred to as 'Offshore R&D Engagement' in this research. The offshore R&D unit could either be a subsidiary of a firm or a different company altogether. As noted in Chapter 1, an offshore R&D unit typically does not have a product-market mandate but is simply a part of the globally integrated R&D value chain. Thus, an offshore R&D engagement implies a hierarchical exchange relationship and assumes centrality of the firm headquarters that delegates R&D work to an offshore R&D unit (Doz and Prahalad, 1991). As revealed by the literature review and discussed in Chapter 3, agency theory offers a promising framework for studying such an exchange relationship (Eisenhardt, 1989a). Therefore, in this research, the governance structure for offshore R&D engagement is conceptualized as a principal-agent relationship, in which the firm headquarters that delegates R&D activities is the principal and the offshore R&D unit that is engaged to perform R&D work is the agent (Jensen and Meckling, 1976). This is consistent with the conceptualization of headquarters-subsidiary relations in multinational corporations as principal-agent relationship (Gupta and Govindarajan, 1991; Doz and Prahalad, 1991; Nohria and Ghoshal, 1994, 1997).

4.2.2 Organization and Management of Offshore R&D

This section develops a conceptual view of how offshore R&D engagements are organized and managed. Specifically, three distinct aspects are considered: structural characteristics of offshore R&D engagements, relational characteristics between the firm headquarters and offshore R&D units, and allocation of R&D tasks to offshore R&D units.

4.2.2.1 Structural Characteristics

The literature review in Chapter 2 indicated that firms employ a combination of formal and informal control and coordination processes to govern and integrate their globally dispersed R&D units (Baliga and Jaeger, 1984; Reger, 1999). Control ensures adherence to goals through exercise of authority, whereas coordination encompasses enabling processes that link activities of different task units to achieve the intended goals (Child, 1973; Cray, 1984). Since this research conceptualizes an offshore R&D engagement as principal-agent relationship, drawing on agency theory perspectives reviewed in Chapter 3, it is conceived that the firm headquarters (the principal) will exert either behavioral control or outcome-based control on the offshore R&D unit (the agent). Moreover, the firm headquarters is likely to employ a variety of formal and informal coordination mechanisms to integrate R&D activities performed by the agent and ensure that the agent delivers on the intended objectives (Eisenhardt, 1989a; Martinez and Jarillo, 1989, 1991). In this research, the principal-agent relationship between firm headquarters and offshore R&D unit together with the coordination mechanisms employed define the structural characteristics of offshore R&D engagements.

Research on coordination of globally dispersed R&D suggests that the actual mechanisms employed for structuring the headquarters-subsidiary relationship are determined by the context of the subsidiary and the strategic intent of the firm in globalizing its R&D (Gupta and Govindarajan, 1991; Nohria and Ghoshal, 1994; Nobel and Birkinshaw, 1998). As such, the choice of coordination mechanisms depends on the degree of uncertainty associated with R&D tasks, nature and type of knowledge, division of R&D tasks, and the type of interaction needed between the headquarters and subsidiary (Reger, 2004). However, four coordination mechanisms, namely centralization, formalization, socialization, and communication can be discerned from the literature on globalization of R&D that together constitute a fairly comprehensive characterization of the structure of headquarters-subsidiary relations (Martinez and Jarillo, 1989, 1991; Nohria and Ghoshal, 1997; Nobel and Birkinshaw, 1998). Given the similarity between the structure of an offshore R&D engagement and headquarters-subsidiary relations in multinational corporations, this research, therefore, considers centralization, formalization, socialization and communication as constituents of the structural characteristics of offshore R&D engagements.

However, before exploring the significance of the four coordination mechanisms for governance of offshore R&D, a few important remarks are necessary. First, while centralization, formalization, socialization and communication have been extensively examined in the context of globalization of R&D, most of the studies pertain to headquarters-subsidiary relation contexts in which subsidiaries have their own product-market mandates (e.g., Ghoshal and Bartlett, 1988; Bartlett and Ghoshal, 2002; Nohria and Ghoshal, 1997; Nobel and Birkinshaw, 1998). An offshore R&D unit, in contrast, does not have its own product-market mandate but instead carries out R&D activities for the firm headquarters in a participatory fashion. Second, even though scholars have extensively studied the effects of centralization, formalization, socialization and communication on organizational innovation, most of these studies (a) have been in unitary organizations (b) have often focused on adoption rather than creation of innovation, and (c) produced inconsistent results (Schoonhoven, *et. al.*, 1996; Ravichandran, 2000; Wolfe, 1994; Nohria and Ghoshal, 1997). Therefore, it is necessary to examine the choice and effectiveness of the coordination mechanisms in the particular and unique context of offshoring of R&D.

In the context of an offshore R&D engagement, centralization is the extent to which the locus of decision-making lies with the principal, i.e., the firm headquarters (Martinez and Jarillo, 1989, 1991; Ghoshal and Bartlett, 1988; Nohria and Ghoshal, 1997). In an offshore R&D engagement, centralization is expected to be high due to the emphasis on R&D efficiency and the need to centrally orchestrate R&D for global innovations. Accordingly, the principal is likely to adopt centralization as a key coordination mechanism (Bartlett and Ghoshal, 2002; Nobel and Birkinshaw, 1998). The extent of centralization in an offshore R&D engagement is assessed by examining the relative influence of the agent on following types of decisions: (a) overall direction for, and allocation of work to, the offshore R&D unit, (b) determination of resource levels and budget for the offshore R&D unit, (c) determination of R&D project priorities, and definition of the project plan and schedule, (d) development of new products and enhancement of existing products, (e) modifications to R&D and product development processes, and (f) recruitment and development of R&D staff at the offshore R&D unit (Bartlett and Ghoshal, 2002; Brockhoff and Schmaul, 1996; Nobel and Birkinshaw, 1998).

Formalization refers to the extent to which policies, documented procedures, and written job descriptions, etc. are used such that they lead to establishment of organizational routines (Martinez and Jarillo, 1989, 1991; Nohria and Ghoshal, 1997). In offshoring of R&D, the firm headquarters is likely to use common standards and processes to coordinate and integrate distributed innovation tasks between two locations that are separated by time, distance, and culture. Similarly, use of documented R&D process manuals may provide common terminology and work procedures, and help alleviate problems arising from differences in interpretation due to cultural heterogeneity. Finally, the principal is likely to rely on formal R&D project reports in order to monitor the progress and performance of the geographically distant agent. In this research, the extent of formalization is assessed by (a) checking for existence of common standards, rules and manuals for R&D tasks, (b) examining reporting procedures and protocols for R&D project activities, and (c) use of formal project plans and reviews (Nobel and Birkinshaw, 1998; Persaud, *et. al.*, 2002; Kim, *et. al.*, 2003).

Also, the principal is likely to rely on both centralization and formalization to address the interdependencies between two locations that may arise in offshoring of R&D (Nobel and Birkinshaw, 1998). In particular, the principal is likely to use formal project plans and centralized project management to deal with the participative nature of task environment, which may give rise to high sequential and reciprocal interdependencies between the principal and agent (Baliga and Jaeger, 1984; Nobel and Birkinshaw, 1998). Sequential interdependence refers to a situation where outputs produced by an agent are fed into the principal (or vice versa), whereas in situations of reciprocal interdependence outputs are fed back and forth between the principal and agent. However, managing such interdependencies may be challenging given the geographical and cultural distances. Thus, use for formal project plans that define the division of tasks and contain clear description of roles and responsibilities for offshore R&D units may be crucial (a) for effectively managing interdependencies between locations, (b) for establishing accountability for performance, and (c) to avoid any duplication of effort (Baliga and Jaeger, 1984).

Communication refers to formal and informal exchange of information between the agent and principal (Allen, 1977; Rogers, 1983; Martinez and Jarillo, 1989, 1991; Kim, *et. al.,* 2003). In this research, the level of communication in an offshore R&D engagement is assessed by checking for (a) frequency and density of face-to-face and other types of communication and (b) the content and quality of communication (De Meyer, 1991; Ghoshal and Bartlett, 1988; Persaud, *et. al.,* 2002; Nobel and Birkinshaw, 1998). Flow of communication is crucial when the interdependencies between the principal and agent are high (Gupta and Govindarajan, 1991, 2000; Nobel and Birkinshaw, 1998). Accordingly, if the task interdependence between the headquarters and offshore R&D unit is high, higher frequency and density of formal and informal communication patterns may be expected (Burns and Stalker, 1961; Lawrence and Lorsch, 1967; Nobel and Birkinshaw, 1998). However, in offshoring of R&D, both geographical distance (physical distance and time zone difference) and cultural heterogeneity (language difference) may impact communication quality and frequency, and limit flow of communication (Allen, 1977; Buckley and Carter, 2004). In view of this, an offshore R&D engagement may exhibit a greater emphasis on formal communication using electronic and communication infrastructure.

Socialization refers to deliberate managerial actions aimed at promoting shared norms and values and building inter-personal familiarity among the people involved in an offshore R&D engagement (Martinez and Jarillo, 1991; Baliga and Jaeger, 1984). Many empirical studies suggest the primacy of socialization in management of global R&D (Martinez and Jarillo, 1989; Ghoshal and Bartlett, 1988, Gupta and Govindarajan, 2000). Socialization leads to high level of normative integration between locations (Nohria and Ghoshal, 1997) and helps overcome the negative effects of distance on communication frequency and density through established informal relations between members of globally dispersed units (Hansen and Lovas, 2004). Socialization also helps overcome agency problems (Nohria and Ghoshal, 1994) and affirms procedural justice (Kim and Mauborgne, 1995, 1998). Socialization is particularly useful when the level of reciprocal interdependence between geographically separated teams is high (Nobel and Birkinshaw, 1998). Therefore, socialization appears to be an important mechanism for coordination of offshore R&D activities.

However, socialization costs money (Bartlett and Ghoshal, 2002), and excessive use of socialization may compromise the efficiency seeking motive in offshoring of R&D. Moreover, since the cultural distance in offshoring of R&D is high, socialization may not be fully effective since it is based on shared norms, values, and behaviors (Reger, 1999). In this research, the extent of socialization in an offshore R&D engagement is assessed by (a) frequency and volume of visitors from the headquarters to offshore R&D unit and vice versa, (b) degree of participation in job rotation programs, (c) exchange of R&D staff between two locations, (d) existence of cross-location committees and groups, and (e) availability of organizational platforms that facilitate interaction among members from both sites (Nohria and Ghoshal, 1997; Ghoshal and Bartlett, 1988, Nobel and Birkinshaw, 1998; Persaud, 2005; Gupta and Govindarajan, 2000).

4.2.2.2 Relational Characteristics

Drawing on the literature review, this research considers three attributes for characterizing the relation between the principal and agent: trust and credibility, distance, and procedural justice. Trust provides the foundation for effective governance and also plays an important role in constraining opportunism in an exchange relationship (Dyer and Singh, 1998; Casson, *et. al.*, 2006). Trust between the actors plays a key role in facilitating the progression of the exchange relationship (Dyer and Chu, 2003; Ryan, *et. al.*, 2004). Trust positively influences attitudes and behavior of organizational actors, and fosters cooperation between them. Trust develops mutual respect, and improves confidence, predictability, and performance (Mayer, *et. al.*, 1995l; Dirks and Ferrin, 2001). Several factors determine the level of trust in a principal-agent relationship: agent's ability or competence, credibility, integrity, reliability, and benevolence (Ryan, *et. al.*, 2004; Mayer, *et. al.*, 1995).

In this research, trust refers to the degree of mutual respect, appreciation and confidence that principal and agent have for each other, as well as their respective beliefs that each will act to advance the best interests of the other. The following indicators are used to observe the degree of trust in an offshore R&D engagement: (a) experiences of the principal and agent with each other, (b) principal and agent's level of mutual respect for each other, (c) principal and agent's perception of each other's integrity, (d) principal and agent's attitude of caring for each other. Credibility, on the other hand, concerns the level of principal's confidence in the agent's ability to successfully deliver on the assigned objectives. Agent's credibility can be assessed by (a) principal's perception of the agent's demonstrated technical contributions, (b) evolution in agent's R&D responsibility/scope over time, (c) principal's propensity to entrust high-risk work to the agent, and (d) predictability of the agent's performance as perceived by the agent.

In globalization of R&D, distance is considered to negatively impact the ability of a firm to effectively integrate its globally distributed R&D units and achieve efficient transfer of knowledge (Howells, 2000; Szulanski, 1996; Gupta and Govindarajan, 2000; Singh, 2008). In this research, three dimensions of distance are considered: physical distance between two locations involved in an offshore R&D engagement, time zone differences between locations, and cultural distance arising from cultural heterogeneity (Buckley and Carter, 2004). Involvement of actors from two different countries implies physical distance, whereas time zone distance suggests that the principal and agent are located in two different time zones, with some or no overlap between their working hours. In this research, only language difference between two locations is considered as indicator of cultural distance (Buckley and Carter, 2004).

Finally, procedural justice refers to the extent to which the agent considers the dynamics of principal's decision-making processes pertaining to offshoring of R&D to be fair. Bilateral communications between the principal and agent positively influences procedural justice (Kim and Mauborgne, 1995, 1998). Prevalence of procedural justice in an offshore R&D engagement is assessed by investigating (a) the ability of the agent to participate in strategy-making process related to offshoring of R&D, (b) the ability of the agent to legitimately challenge principal's views, (c) the extent to which the agent is given an account of principal's decisions that affect the offshore R&D engagement, and (d) consistency of principal's decisions that impact the agent.

4.2.2.3 R&D Task Allocation

R&D task allocation refers to division of responsibilities between two locations and allocation of R&D tasks to offshore R&D unit. Although the literature on R&D globalization discusses various types of global R&D units and their integration for transnational innovation (e.g., Bartlett and Ghoshal, 2002; Gassmann and von Zedtwitz, 1999), studies that explicitly examine aspects related to allocation of R&D tasks are not apparent. Due to the participatory nature of innovative activities in offshoring of R&D, partitioning and allocation of R&D tasks assume particular importance. In offshoring of R&D, the principal determines the scope and objectives of innovative activities and allocates tasks to agent with the motive to access knowledge resources and gain R&D efficiency.

Intuitively, an offshore R&D unit may be allocated tasks to create an innovative output (e.g., product, component, etc.), or it may be engaged to contribute certain innovative activities in support of a larger innovation objective. Since distance makes coordination and integration across geographical and cultural boundaries costly and difficult

(Buckley and Carter, 2004), it is conceivable that a firm would seek to minimize interdependencies between locations while allocating R&D tasks to offshore R&D unit. Also, an offshore R&D unit's credibility may influence R&D task allocation decisions (Birkinshaw, *et. al.,* 1998). The prospect of gaining innovation speed by systematically exploiting the time zone differences between the firm headquarters and offshore R&D unit may also influence R&D task allocation (Boghani, *et. al.*, 1998; Doz, *et. al.*, 2006). In addition, a firm may seek to leverage offshore R&D for achieving innovation variety by allocating work that requires creation of variants of existing innovations.

At a fundamental level, a firm could allocate either an autonomous innovative task or systemic innovative task to an offshore R&D unit (Chesbrough and Teece, 1996; Teece, 1998). Allocation of systemic innovation task would require high levels of interdependence between the firm headquarters and offshore R&D unit, whereas autonomous innovative tasks could be pursued more or less independently (Chesbrough and Teece, 1996; Teece, 1998). Work allocation to an offshore R&D unit may also be driven by considerations of core and non-core R&D activities (Quinn, *et. al.*, 1987). Also, the choice between intra-firm or inter-firm offshoring of R&D may depend on competitive significance of knowledge and risks associated with R&D tasks (Bardhan and Jaffe, 2005). The literature review suggests that a firm is likely to pursue inter-firm R&D offshoring (offshore R&D outsourcing) for non-core or complementary R&D activities (Fraser and Oppenheim, 1997).

4.2.3 Offshoring of R&D and Firm Innovative Capability

Innovative capability refers to the ability of a firm to create innovative outputs. As discussed in Chapter 3, there are two different literature streams that address firm innovative capability: (a) organizational structure – innovative capability and (b) knowledge creation, knowledge transfer and knowledge integration. Drawing on these two literature streams and the literature review (Chapter 2), this section explores the link between offshoring of R&D and firm innovative capability. As shown in Figure 4.2, in this research, dual paths to firm innovative capability in offshoring of R&D are conceptualized: (a) generation of innovative outputs by the offshore R&D unit and (b) transfer of knowledge from the offshore R&D unit to the firm headquarters. Generation of innovative outputs by offshore R&D unit is an outcome of the structural characteristics of an offshore R&D engagement as well as various firm attributes. On the other hand, transfer of knowledge from an offshore R&D unit to the firm headquarters depends on a number of factors, as depicted in Figure 4.1. This section conceptually explores the dual paths to innovative capability in offshoring of R&D.

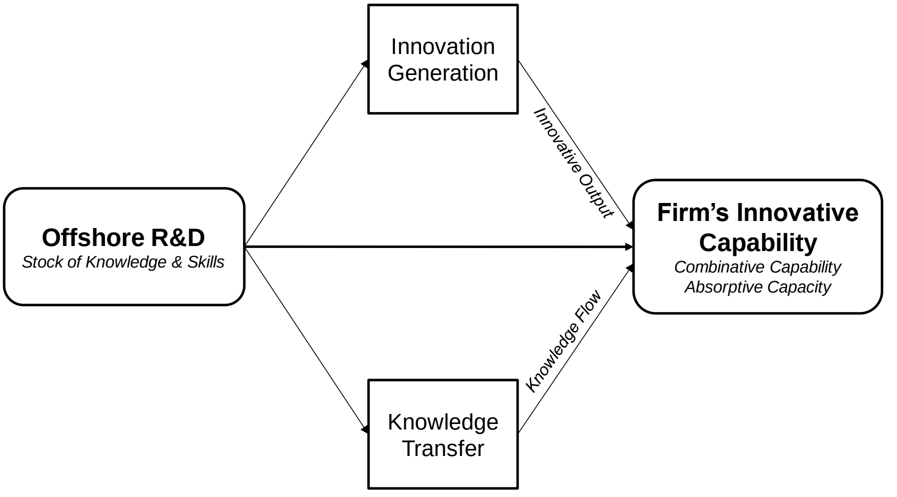


Figure 4.2: Dual Paths to Innovative Capability

4.2.3.1 Innovation Generation by Offshore R&D Unit

As discussed in Section 4.3.2.1, a principal-agent relationship together with four coordination mechanisms—centralization, formalization, communication, and socialization characterize the structure of an offshore R&D engagement. Thus, the ability of an offshore R&D unit to produce innovative outputs will be an outcome of the structural characteristics of the engagement (Lam, 2005; Ghoshal and Bartlett, 1988; Nohria and Ghoshal, 1997; Nobel and Birkinshaw, 1998).

Generally, centralization is regarded as costly, bureaucratic, and inhibiting an organization's ability to innovate (e.g., Damanpour, 1991; Ghoshal and Bartlett, 1988; Egelhoff, 1988a; Nohria and Ghoshal, 1997). Research shows that the degree of autonomy of global R&D units is positively correlated with their ability to innovate (Ghoshal and Bartlett, 1988; Nohria and Ghoshal, 1997; Nobel and Birkinshaw, 1998; Persaud, 2005). Accordingly, it may be expected that when the level of autonomy of an offshore R&D unit is high, its ability to produce innovative contributions will also be high. However, due to the participatory and distributed nature of innovative work, often involving high levels of interdependence between two locations, the principal is likely to employ centralization as the key coordination mechanism for orchestrating offshore R&D activities. Also, if the time pressure for innovation is high, the principal is likely to exhibit a greater preference for centralization (De Meyer and Mizushima, 1989).

Like centralization, there is growing consensus among organizational innovation and R&D globalization scholars that formalization causes rigidity, stifles creativity, and hampers innovation (e.g., Damanpour, 1991; Ghoshal and Bartlett, 1988; Kim, *et. al.*, 2003). Especially since the process of R&D is unstructured and tacit, formalization is considered to be ineffective for coordination of R&D activities (Kim, *et. al.*, 2003). Nevertheless, in offshoring of R&D, an optimal level of formalization may be necessary for effective integration of distributed and interdependent innovation tasks that are separated by time and distance. In the absence of any formalization—for example, no use of standards—an offshore R&D team may produce innovative outputs that cannot be integrated into the overall innovation efforts of the firm. Similarly, if documented project plans with well-defined deliverables and roles and responsibilities are not used, misalignment and duplication of efforts across location may happen. On the other hand, excessive formalization will likely suppress the creative efforts of offshore R&D team members and also cause delays in R&D processes.

Numerous studies emphasize the positive role of communication on the innovative capability of a firm (Burns and Stalker, 1961; Allen, 1977; Tushman, 1979; Ghoshal and Bartlett, 1988). Research suggests that the flow of communication between geographically dispersed sites builds trust and results in the formation of personal networks, which, in turn, facilitate greater interaction and learning (De Meyer, 1991; Kogut and Zander, 1992; Ghoshal and Bartlett, 1988). Therefore, higher frequency and density of formal and informal communications in an offshore R&D engagement is expected to positively contribute to the firm innovative capability. Similarly, the R&D globalization literature suggests that socialization has a significant positive influence on the innovative capability of firms (Nohria and Ghoshal, 1997; Ghoshal and Bartlett, 1988, Gupta and Govindarajan, 2000). Socialization promotes interactions among members in geographically dispersed units and positively impacts knowledge creation and innovation (Ghoshal and Bartlett, 1992; Burns and Stalker, 1961; Allen, 1977; Kim and Mauborgne, 1995; Gupta and Govindarajan, 2000; Hansen, 2002). Accordingly, socialization in an offshore R&D engagement is expected to positively influence the firm innovative capability.

4.2.3.2 Knowledge Transfer from the Offshore R&D Organization to Firm Headquarters

In this research, knowledge transfer refers to the flow of knowledge from an offshore R&D unit to the firm headquarters (Dierickx and Cool, 1989; Szulanski, 1996). As discussed earlier, the ability to efficiently transfer knowledge from an offshore R&D unit to the firm headquarters is an important determinant of firm innovative capability (Kogut and Zander, 1992; Grant, 1996b). An offshore R&D unit may possess stock of knowledge that is either duplicated (similar to the firm headquarters) or specialized and complementary, or both. Duplication strengthens the existing stock of knowledge and enables cross-fertilization through pooling of resources and ideas that result in new knowledge creation. Specialized and complementary knowledge, on the other hand, expands a firm's existing stock of knowledge and catalyzes new knowledge creation (Kogut and Zander, 1992; Nonaka and Takeuchi, 1995; Zander, 1999; Rosenkopf and Nerker, 2001). Complementary knowledge may not necessarily be unique but may be essential for successful innovation (Teece, 1986, 1998).

Discussions in Chapter 3 suggest that if the knowledge is codifiable, it may be easily communicated and transferred, whereas transfer of tacit, contextually-embedded knowledge from an offshore R&D unit to the firm headquarters may be difficult (Szulanski, 1996). Tacitness of knowledge would increase the cost and decrease the speed of knowledge transfer (Kogut and Zander, 1993). The spatial and cultural distances may also affect the flow of knowledge from an offshore R&D unit to the firm headquarters (Buckley and Carter, 2004). The transfer of knowledge from an offshore R&D unit to firm headquarters may be accomplished through codification (documents, reports, etc.), embodiment in innovative outputs (e.g., products, components, etc.), communication (meetings, emails, etc.), and social interactions (Grant, 1996b; Howells, 2000; Buckley and Carter, 2004). Social interactions are likely to be the most efficient mechanism for transfer of knowledge because they improve frequency of communication, promote common knowledge, and induce formation of "communities of creation" (Grant, 1996a, 1996b; Brown and Duguid, 1991; Nonaka and Takeuchi, 1995; Grant, 1996a, 1996b; Gupta and Govindarajan, 2000; Tsai and Ghoshal, 1998).

Discussions in Chapter 3 also suggest that knowledge transfer from an offshore R&D unit to the firm headquarters would depend on motivational disposition of the headquarters as well as its absorptive capacity (Szulanski, 1996; Cohen and Levinthal, 1990; Gupta and Govindarajan, 2000; Frost and Zhou, 2005). Absorptive capacity of the headquarters would depend on path dependence of learning through which its existing stock of knowledge has accumulated (Cohen and Levinthal, 1990; Kotabe, *et. al.*, 2007). The NIH (not invented here) syndrome, considerations of the opportunity cost of time, and perception of value and credibility may serve as impediments to the headquarters' motivation and willingness to absorb knowledge from an offshore R&D unit (De Meyer, 1993a; Gupta and Govindarajan, 2000; Teigland, *et. al.*, 2000). However, the headquarters is likely to demonstrate propensity towards knowledge absorption from an offshore R&D unit if the stock of knowledge of the offshore R&D unit is (a) related to what the headquarters already knows and (b) relevant and relatively new to the headquarters (Gupta and Govindarajan, 2000; Hansen and Lovas, 2004; Song and Shin, 2008).

In other words, the perception of knowledge differential and its value may stimulate the headquarters to engage in transferring knowledge from an offshore R&D unit. In addition, if an offshore R&D unit's knowledge credibility based on demonstrated results is high, it is expected to catalyze the process of knowledge transfer from the offshore R&D unit to the firm headquarters (De Meyer, 1991). On the other hand, as discussed in Chapter 3, the willingness of an offshore R&D unit's members to transfer knowledge to the firm headquarters is likely to be influenced by their perception of procedural justice (Kim and Mauborgne, 1991, 1996, 1998) and existence of incentives (Gupta and Govindarajan, 2000). Thus, if the members of an offshore R&D unit are recognized and valued by the firm headquarters for their expertise and intellectual worth, and are treated with fairness, dignity, and respect, procedural justice will prevail and knowledge transfer will materialize (Kim and Mauborgne, 1991, 1996, 1998). Finally, an explicit focus on establishing a knowledge sharing culture that enhances curiosity and openness for new ideas may also facilitate knowledge transfer from an offshore R&D unit to the firm headquarters (Teigland, *et. al.*, 2000).

4.2.3.3 R&D Task Allocation, Organizational Attributes, and Firm Innovative Capability

In addition to structural characteristics and knowledge transfer processes, in offshoring of R&D, patterns of task allocation and organizational attributes of the firm also influence innovative capability of firms. For example, studies on determinants of innovation suggest that an organization's size is positively associated with its innovative capability (e.g., Damanpour, 1991). By offshoring R&D, a firm gains access to additional R&D capacity, which may have a positive influence on its innovative capability. Also, slack resources are vital to a firm's innovative capability (Cyert and March, 1992; Damanpour, 1991) because they permit experimentation with new innovation ideas and development of new capabilities (Nohria and Ghoshal, 1997; Nohria and Gulati, 1996). Offshoring of R&D permits a firm to maintain slack R&D resources at low costs and thus improve its innovative capability.

Studies show that the age of an organization inhibits its innovative capability because of the established and mature organizational routines, which cause structural inertia and cultural rigidity (Leonard, 1995; Ahuja and Lampert, 2001). A firm may overcome the effects of its 'heritage' by leveraging offshoring of R&D to initiate new learning and technological trajectories, and carry out exploratory innovation tasks of strategic importance. In addition, due to differences in path dependence and cultural orientation, an offshore R&D unit may exhibit a different cognitive style. A firm can systematically leverage the diversity in cognitive styles offered by offshore R&D units to enhance its innovative capability (Leonard, 1995).

The competitiveness of a high technology firm depends on its ability to simultaneously pursue a balanced portfolio of exploitative and exploratory innovations (March, 1991). However, the nature of innovative tasks, organizational structures, risks, and learning trajectories associated with exploitation and exploration differ (Gupta, *et. al.*, 2006). Due to path dependency of organizational routines, a firm may find it hard to develop the capability to simultaneously pursue exploitative and exploratory innovations within the same R&D organization (Nelson and Winter, 1982; Tushman and O'Reilly, 1996). It may, therefore, be conceived that a firm's task allocation strategy for offshoring of R&D is likely to be influenced by the opportunity to segregate exploitative and exploratory innovations to achieve ambidexterity at the firm level (Tushman and O'Reilly, 1996, 1997).

Finally, if allocation of tasks to an offshore R&D unit is such that it seeks to minimize interdependencies between locations, knowledge creation and transfer may be compromised because reduced interdependencies would limit the extent of social interactions (Kogut and Zander, 1992; Nonaka and Takeuchi, 1995). Also, the nature and quality of work allocated to an offshore R&D unit affects the level of job satisfaction of its members and determines the quality and quantity of their innovative contributions. Work allocation that heightens job satisfaction and motivation levels of offshore R&D team members may be expected to positively affect firm innovative capability (Pierce and Delbecq, 1977; Mudambi, *et. al.*, 2007).

4.2.4 Offshoring of R&D and Organizational Flexibility

This research views offshoring of R&D as a new global organizational form, and employs the framework advanced by Volberda (1996, 1998) to explore the various dimensions of organizational flexibility in the context of offshoring of R&D. As discussed earlier, offshoring of R&D endows a firm with knowledge resources at relatively low cost structures. Given this, a firm may accumulate and maintain slack at its offshore R&D unit with relatively small investment. Whenever there is fluctuation in the market demand, the firm may be able to quickly leverage the low cost offshore R&D resources to adjust its volume or mix of products to address the emergent market demands. In this way, the firm may be able to produce a number of different products or product variants at the same time, or accelerate delivery of products due to the added R&D capacity (Suarez, *et. al.*, 1991). In another scenario, a firm may leverage the pool of resources available at one of its offshore R&D outsourcing partners to rapidly assemble teams with diverse technical capabilities to address an emergent market opportunity. Thus, offshoring of R&D may be viewed as a low-cost option for a firm to gain operational flexibility, and thus have the ability to respond effectively to familiar changes in its business environment (Volberda, 1996).

The evolutionary path of a firm's R&D organization and its established organizational routines could result in structural inertia that may affect its ability to adapt (Nelson and Winter, 1982; Leonard, 1995; Volberda, 1996). A firm may leverage offshoring of R&D to adapt its structure in accordance with the emergent requirements and changes in the business environment to implement new organizational processes and create new R&D groups. Strategically, a firm may leverage offshoring to establish a new R&D

unit to traverse a different learning trajectory in anticipation of changes in the firm's competitive environment. Similarly, a firm may adapt to environmental changes by sourcing and integrating knowledge assets from an offshore outsourcing partner to create new technologies and products (Sanchez, 1995; Volberda, 1996). Thus, it may be conceived that offshoring of R&D allows a firm to adapt to its environment by achieving new structural configurations at low costs.

Finally, when the changes in a firm's business environment are fast, incomprehensible, and substantial, the firm may leverage offshoring of R&D to rapidly pursue fundamentally new strategic directions, incorporate new technologies in its products, create a completely new product-market combination, and radically transform its products. The firm may partner with an offshore R&D outsourcing partner to create new products for new markets or disrupt the existing markets. The firm may also leverage offshoring of R&D to develop a diversified R&D portfolio at low cost, and thus enhance its repertoire of strategic flexibility options (Buckley and Cason, 1998; Aaker and Mascarenhas, 1984; Bowman and Hurry, 1993). Thus, offshoring of R&D may be conceived to confer strategic flexibility to a firm by providing an enhanced adaptive capacity at low cost (Evans, 1982; Hitt, *et. al.*, 1998; Sanchez, 1997).

4.3 SUMMARY

Integrating insights from the literature review with the theoretical underpinnings discerned in Chapter 3, this chapter developed the conceptual lens for sense-making during empirical research. As the conceptual lens suggests, offshoring of R&D presents a firm with dual paths to innovative capability. On one hand, an offshore R&D unit may contribute to a firm's innovative capability by producing innovative outputs. On the other hand, a firm can transfer and integrate knowledge created by an offshore R&D unit to augment its innovative capability (Venaik, *et. al.*, 2005). The structural characteristics of an offshore R&D engagement influence both the creation of innovative outputs and transfer of knowledge to the firm headquarters. Transfer and integration of knowledge from an offshore R&D unit into the firm is determined by the characteristics of knowledge, the knowledge transfer mechanisms, and motivational dispositions of both the firm headquarters and offshore R&D unit.

Further, as explained, the ability of a firm to leverage offshoring of R&D for innovative capability also depends on how it partitions tasks and allocates R&D activities to the offshore R&D unit. In addition, a number of organizational attributes of the firm (e.g., size, age, etc.) and offshore R&D unit (e.g., stock of knowledge, slack resources, etc.), as well as the attributes of the relationship between the firm and offshore R&D unit (trust, credibility, distance, and procedural justice) moderate the ability of the firm to gainfully leverage offshoring of R&D for innovative capability. As the preceding discussion suggests, under conditions of effective coordination and efficient knowledge transfer, a firm can leverage offshoring of R&D to enhance its innovative capability and achieve higher innovation volume, innovation variety and innovation speed.

Furthermore, offshoring of R&D can confer upon a firm the ability to develop and leverage a repertoire of flexible response options that permits it to achieve congruence with the demands of its business environment. In offshoring of R&D, organizational flexibility options arise from the resource flexibility of an offshore R&D unit and the proficiency of the firm headquarters to configure and deploy the offshore R&D unit's resources. Finally, as discussed in Chapter 3, organizational flexibility and innovative capability are mutually supportive. Firm innovative capability and organizational flexibility are two most important dynamic capabilities of high technology firms. This chapter conceptually illuminated on the link between offshoring of R&D and the firm innovative capability and organizational flexibility. As the conceptual analysis suggests, offshoring of R&D has a positive linkage with a firm's innovative capability and organizational flexibility. Thus, it may be construed that offshoring of R&D is also positively associated with a firm's dynamic capabilities.

CHAPTER 5
RESEARCH METHODOLOGY

CHAPTER 1 NOTED that despite the growing propensity of offshoring of R&D the scholarly literature that directly and systematically deals with the focal aspects of the phenomenon is yet to develop. As such, no theory was readily available that could guide the study. However, as Chapter 2 revealed, some strands of the R&D globalization literature juxtaposed with theoretical underpinnings discussed in Chapter 3 held the promise to inform this research. Thus, Chapter 4 focused on developing a conceptual lens by integrating the insights generated from the R&D globalization literature with relevant elements of theories of organizational innovation, organizational flexibility literature, and the broader organizational economics and strategic management perspectives. Since this research aimed to acquire an in-depth understanding of the terrain of the phenomenon of offshoring of R&D, adopting a research approach that would reveal the 'inside picture' and lead to development of new, grounds-up understanding was necessary.

This research employed a *multiple case study strategy* with *an inductive logic* to *interpretively* generate a descriptive and explanatory theory to understand the link between offshoring of R&D and a firm's innovative capability and organizational flexibility. This chapter explicates the research methodology used to carry out the study and is organized as follows. First, the empirical research approach is described in detail, encompassing the research philosophy, strategy, and the methods for data collection and analysis. Next, the issues related to the quality, validity, and generalizability of this research are discussed. This is followed by a discussion on the ethical aspects involved in this research and how they were dealt with. Finally, the chapter concludes with a description of the end-to-end process used to carry out the research. To be clear, the purpose of this chapter is *not* to provide an overview of the various research philosophies and methods. Instead, the endeavor in this chapter is to discuss and explain the adoption of the particular research paradigm and the methods used to accomplish the stated research objectives.

5.1 INTERPRETIVE RESEARCH APPROACH

This study adopts an interpretive research approach, which may be viewed as a subset of qualitative research (Prasad and Prasad, 2002). However, in an interpretive approach to research, the key point of departure is at the level of a paradigm rather than methods (Lincoln and Guba, 1985; Prasad and Prasad, 2002). Interpretive research approaches are rooted in the philosophy of interpretivism, also known as the interpretivist paradigm (Blaikie, 2000; Prasad and Prasad, 2002; Miles and Huberman, 1984). This section describes the interpretivist paradigm, discusses its salient features and strengths, and compares and contrasts it with positivism. This is followed by a brief discussion of the characteristics of interpretive research and the principles that govern it. Finally, this section concludes with an explanation of why adopting an interpretive research approach was most appealing and appropriate for this study.

5.1.1 The Interpretivist Paradigm

In the realm of research methodology, interpretivism and positivism are the two major philosophical traditions or research paradigms. These two paradigms have different epistemological and ontological assumptions, contrasting characteristics and nuances, and are generally regarded as being in opposition (Lee and Baskerville, 2003). The positivist research philosophy has roots in logical positivism. It treats the phenomenon of interest as single, tangible and fragmentable, and believes that a unique, best description of any chosen aspect of the phenomenon is achievable. The positivist paradigm views the researcher and the object of inquiry as separate, and inquiry as such to be value-free (Creswell, 2003; Orlikowski and Baroudi, 1991). It embraces a hypothetico-deductive approach to knowledge and analysis with the aim of generating nomothetic outputs, and claims that time- and context- free generalizations are possible. Positivism does not differentiate between natural and social sciences, and considers the scientific methods of natural sciences to be perfectly and equally applicable to social sciences (Lee and Baskerville, 1991; Lincoln and Guba, 1985). Positivism believes that it is perfectly feasible, and actually, the only genuine way, to acquire an objective understanding of a phenomenon without getting involved in it (Lee and Baskerville, 2003; Weber, 2004). In practical terms, positivist research is premised on the existence of a priori relationships within a phenomenon, which is typically examined with structured instrumentation and seeks to test theory with the goal of generating predictive understanding of the phenomenon (Lincoln and Guba, 1985; Orlikowski and Baroudi, 1991; Lee and Baskerville, 2003).

However, positivism has come under strong criticism from many organizational researchers who consider the paradigm to be inappropriate and ineffective for studying social and organizational phenomena or processes (e.g., Lincoln and Guba, 1985; Sandberg, 2006; Ghoshal, 2005; Prasad and Prasad, 2002). According to Lincoln and Guba (1985), conceptualization of science in positivism is deemed to be inadequate because it confuses between the context of discovery (genesis of theories) and context of justification (testing of theories). Positivism emphasizes prediction and control as well as temporal and contextual independence of observations while ignoring understanding and description. It also suffers from an overdependence on operationalism. Positivism’s inability to satisfactorily deal with the interacting aspects of theory-fact relationship and its characteristics of determinism and reductionism are considered to be its major inadequacies (Lincoln and Guba, 1985; Mason, 2002).

Moreover, positivism completely disregards the presence and influence of humans and human intentionality, which are not only integral but central to organizational settings and processes. This is a particularly serious limitation of positivism because it produces research with human respondents but ignores their humanness (Lincoln and Guba, 1984). A highly regarded management science scholar with a distinguished research track record observed (Ghoshal, 2005):

> *Business research has increasingly adopted the "scientific" model—an approach that has led to theorizing based on partialization of analysis, the exclusion of any role for human intentionality or choice, and the use of sharp assumptions and deductive reasoning. This ideology has led management research increasingly in the direction of making excessive truth-based claims based on partial analysis and both unrealistic and biased assumptions.*
>
> *…Unfortunately, as philosophy of science makes clear, it is an error to pretend that the methods of physical sciences can be indiscriminately applied to business studies because such a pretension ignores some fundamental differences that exist between different academic disciplines. Management theories at present are overwhelmingly causal or functional in their modes of explanation. Human intentionality, however, is a mental phenomenon.*
>
> *…Because of the very nature of the social phenomenon, which Von Hayek (1989) described as "phenomena of organized complexity," the application of scientific methods to such phenomena "are often the most unscientific, and, beyond this, in these fields there are definite limits to what we can expect science to achieve.*

In contrast to positivism, humans and human intentionality are integral to the interpretivist paradigm (Lincoln and Guba, 1985), which is premised on the notion of the 'social construction of reality' (Berger and Luckmann, 1967). The interpretivist tradition of research does not subscribe to the notion of a single, objective reality. Instead, it acknowledges the existence of multiple realities, which are socially constructed by human actors. So, search for meaningful elements in a complex, multi-layered and textured social world is paramount in interpretivism (Mason, 2002). Interpretivism believes that the researcher and the phenomenon or situation under study cannot be separated if one were to acquire a holistic understanding and, therefore, rejects the notion of value-free inquiry (Lincoln and Guba, 1985; Orlikowski and Baroudi, 1991; Lee and Baskerville, 2003).

The focus in the interpretivist paradigm is on people's subjective and inter-subjective meanings to obtain their perspectives on a phenomena or event and to understand the particular contexts in which they act, as well as the influence of that context on their behavior and actions (Maxwell, 1996). Thus, interpretivism adopts the position that the knowledge of reality is a social construction by human actors (Walsham, 1995). Also, interpretivism regards as inappropriate the goal of discovering universal laws for the study of human affairs because individuals, groups, and other organizational units are all unique. Instead, in interpretivism, idiographic theorizing is emphasized (Orlikowski and Baroudi, 1991). The major task of research in interpretivist paradigm is to tease out the interpretations of the various actors about the social reality in a given setting and bring them into conjunction as far as possible (Guba and Lincoln, 1989). According to Blaikie (2000):

> *Interpretivists are concerned with understanding the social world people have produced and which they reproduce through their continuing activities. This everyday reality consists of the meanings and interpretations given by the social actors to their actions, other people's actions, social situations, and natural and humanly created objects. In short, in order to negotiate their way around and make sense of it, social actors have to interpret their activities together, and it is these meanings, embedded in language, that constitute their social reality.*

The underlying premise in the interpretive paradigm is that individual actions are driven by the meanings that things have for them. The meanings arise out of social interactions and are developed and modified through an interpretive process (Orlikowski and Baroudi, 1991). Hence, organizations, organizational norms and practices, division of labor, and social relations and their dynamics are essentially products of social exchange between organizational actors and are reinforced through their actions and interactions (Mir and Watson, 2000). Thus, unlike the premises of positivism, where the aim is to "discover" an objective social reality, the interpretivist paradigm believes that social reality can only be interpreted. Also, in contrast to positivism, inquiry in interpretivist paradigm is considered value-bound, implying that the researchers' prior assumptions, beliefs, values and interests always intervene to shape their investigations (Lincoln and Guba, 1985; Orlikowski and Baroudi, 1991; Mir and Watson, 2000). Thus, interpretivism involves not only acquiring a subjective understanding but also an interpretive analysis of a situation or phenomenon (Lee and Baskerville, 1991; Orlikowski and Baroudi, 1991; Mir and Watson, 2000). Table 5.1 contrasts positivism with interpretivism along several dimensions.

Table 5.1: Positivism versus Interpretivism

(Sources: Weber, 2004; Gillham, 2000; Lincoln and Guba, 1985)

Meta-theoretical Assumptions About	Positivism	Interpretivism
Ontology	Researcher and reality are separate (single, objective, and fragmentable reality; the whole is simply the sum of the parts)	Researcher and reality are inseparable (multiple, socially-constructed realities, which are also contextual)
Epistemology	Objective reality exists beyond the human mind (independence between the knower and the known)	Knowledge of the world is intentionally constituted through a researcher's lived experience (interaction between the knower and the known)
Research Object	Research object has inherent qualities that exist independently of the researcher	Research object is interpreted in light of meaning structure of researcher's lived experiences
Method	Experimental (statistical analysis)	Hermeneutics, phenomenology, etc.
Theory of Truth	Correspondence theory of truth: one to one mapping between research statements and reality	Truth as intentional fulfillment: interpretations of research object match lived experience of the object by the researcher
Validity	Certainty: data truly measures reality	Defensible knowledge claims
Reliability	Replicability: research results can be reproduced.	Interpretive awareness: researchers recognize and address implications of their subjectivity
Role of Values	Inquiry is value-free.	Inquiry is value-bound
Focus and Characteristics	Theory testing, universal generalization, linear causality (there are no effects without causes and no causes without effect), temporal and contextual independence of the observations, determinism, reductionism, and pre-ordained research design.	Theory development, analytic or naturalistic generalization, emphasis on socially constructed meaning and understanding, centrality of context, emergent and inductive research design

5.1.2 Interpretive Research: Its Characteristics, Strengths and Principles

Interpretive research is characterized by an exploratory, flexible and inductive approach to inquiry, which is data-driven and in which context assumes strategic significance (Mason, 2002; Trochim, 2001). It is especially suited for exploring new phenomena and generating grounds-up theories about them through a detailed understanding of the organizational processes by which events and actions take place and outcomes develop (Graham, 2000; Maxwell, 1996; Mintzberg, 1979; Sutton, 1997; Trochim, 2001). Its capacity to provide a rich, holistic understanding of particular contexts or phenomena and develop explanations about them is what makes interpretive research very attractive (Mason, 2002; Maxwell, 1996). Interpretive research is based on methods of data generation that are flexible and sensitive to contexts in which data reside, and methods of analysis that emphasize understandings of complexity, context and details to build arguments and explanations (Mason, 2002). In interpretive research, the researcher is the primary instrument for data collection (Creswell, 2003) and the data are “qualitative,” i.e., words (Trochim, 2001; Silverman, 2000; Creswell, 2003). Qualitative data are rich, naturally occurring and contextually grounded (Miles and Huberman, 1984; Silverman, 2000), and “are particularly useful for understanding why or why not emergent relationships hold” (Eisenhardt, 1989b).

The particular strength of interpretive research comes from its inductive logic, a flexible approach to inquiry (Maxwell, 1996; Silverman, 2000; Sutton, 1997; Trochim, 2001), the associated ‘facility’ of progressive focusing (Stake, 1995), and its unrivalled ability to ‘get under the skin’ of an organization to understand what really happens (Graham, 2000). Interpretive research helps uncover the underlying connections among different parts of the phenomenon or situation under study by examining the meanings, structures and norms that constitute it (Orlikowski and Baroudi, 1991). Therefore, the main aim of all interpretive research is to understand how members of a group, through their participation in organizational processes, enact their particular realities and endow them with meaning and to show how these meanings, beliefs and intentions of the members help to constitute their social actions. The interpretivist paradigm regards people as the primary data source, the researcher (human) as the measurement instrument, and entails focus on eliciting people’s (social actors’) perceptions or what Blaikie (2000) refers to as the ‘inside view.’

According to Klein and Myers (1999), there are seven principles that apply to interpretive research:

1. The principle of hermeneutic circle, which suggests that all human understanding is achieved by iterating between the interdependent meaning of parts and the whole that they form.

2. The principle of contextualization, which demands critical reflection of the social and historical background of the research setting, so that the intended audience can see how the current situation under investigation emerged.
3. The principle of interaction between the researchers and the subjects that requires critical reflection on how the data were socially constructed through the interaction between the researcher and the participants.
4. The principle of abstraction and generalization, which requires relating the idiographic details revealed by the data interpretation to theoretical, general concepts that describe the nature of human understanding and social action.
5. The principle of dialogical reasoning requires sensitivity to possible contractions between theoretical pre-conceptions guiding the research design and actual findings with subsequent cycles of revision.
6. The principle of multiple interpretations, which requires sensitivity to possible differences in interpretations among the participants as are typically expressed in multiple narratives or stories of the same sequence of events under study.
7. The principle of suspicion, which emphasizes sensitivity to possible "biases" and systematic "distortions" in the narratives collected from the participants.

However, the opinion is divided as to what constitutes the primary focus of interpretive research. Some researchers (e.g., Stake, 1995; Lincoln and Guba, 1985) emphasize that the aim of interpretive research is primarily a search for happenings, understanding, and thick description. Others, however, suggest that interpretive research should produce explanations, which are generalizable and demonstrate wider resonance (Mason, 2002; Maxwell, 1996). This research adopts this latter view of interpretive research because it not only subsumes the former without compromising effectiveness but also aligns with the objective of studying a phenomenon, which is beyond any single context.

5.1.3 Why an Interpretive Approach for this Research?

Establishing a "fit" between the research paradigm and the focus of research is crucial for effective conduct of an inquiry (Lincoln and Guba, 1985). In this research, the choice of an interpretive approach was necessitated because of the state of the extant literature concerning the phenomenon and its focal aspects, the nature of the research questions, the focus on practice, and the intended contributions. Offshoring of R&D is a recent phenomenon and may be viewed as a subset of globalization R&D. However, as discussed in Chapter 1, the economic and structural considerations underlying offshoring of R&D differ from that of traditional notions of globalization of R&D. As such, the focal aspects of offshoring of R&D that this research is concerned with have yet to be examined systematically. The absence of prior research on the topic and the nature of the research questions implied that the extant literature and theoretical bases offered inadequate support for the inquiry. This necessitated that an inductive research approach be employed so that understanding and explanation rooted in empirical reality could be generatively built in a grounds-up manner. This is consistent with the approach taken by several scholars for exploring new research themes within/concerning the phenomenon of globalization (e.g., Nohria and Ghoshal, 1997; Korine and Gomez, 2002).

Arguably, multiple instances of offshoring of R&D together give rise to and characterize the terrain of the phenomenon. However, as the research questions imply, this is a process-oriented study at the level of a firm, and hence firm-specific factors, idiosyncratic in nature, inevitably come into play in the enactment of individual instances of offshoring of R&D (Maxwell, 1996; Mohr, 1982). Moreover, as the research questions suggest, analysis of practice was central to this research. Thus, it became clear that in order to acquire a broad-based understanding of the phenomenon and its focal aspects, studying its individual instances enacted in specific organizational settings would be necessary. Such a contextual investigation would allow analysis of practices and reveal the underlying structures and processes, understanding which was absolutely essential to answering the research questions. However, a context-dependent understanding of instances of offshoring of R&D and its focal aspects could only be gained from the ‘actors’ who ‘enacted’ the phenomenon and ‘operated’ its associated structures, processes and content. Thus, in order to build understanding and explanation about the focal aspects of the phenomenon, the need to access the perspectives and experiences of organizational actors while focusing on context, content, processes and structure, was pronounced. Moreover, the main constructs that form the core of this study—innovative capability and organizational flexibility—are themselves subjective and hence open to varying interpretations. Therefore, in view of these, an interpretive research approach was adjudged to be the best ‘fit’ for this study. The adoption of interpretive research approach also allowed for the utilization of tacit knowledge (Walsham, 1995; Lincoln and Guba, 1985) of both the researcher and the participants. Such intertwining of the researcher’s personal experiences with the research is considered to be facilitative of ‘intellectual craftsmanship’ in the realm of social and organization science (Mills, 2000).

Astley (1985) has argued that the study of organizations and management is fundamentally a subjective enterprise. According to him, the body of knowledge that constitutes organizational science is a socially constructed product since empirical observations are inevitably mediated by theoretical preconceptions. From that point of view as well, the choice of an interpretive research approach seemed quite appropriate for this study. Also, highlighting the limitations of the positivist approaches several scholars have indicated the need for adoption of interpretive research in studies of organizations and management so as to produce ‘good’ and ‘positive’ management theories (e.g., Ghoshal, 2005). Such ‘voices’ and my own conviction that the complexities of organization and management cannot be reduced to simple cause-effect relationships also inform the selection of the research approach. Interpretive research has been used in a wide range of studies in organization and management science, including product innovation (Dougherty, 1992), technology management and organizational change (Orlikowski, 1993), information systems (Walsham, 1995), organizational change (Pettigrew, 1990), etc. However, traditionally, interpretive research has focused on the micro worlds of organizations and has kept away from the macro provinces of large-scale institutional processes and phenomena (Prasad and Prasad, 2002). This study takes a step towards that direction.

5.1.4 Generalization in Interpretive Research

In general, within the interpretivist tradition, generalization is usually not considered to be the primary goal and, instead, particularization is emphasized (Lincoln and Guba, 1985; Stake, 1995). However, a growing number of scholars consider generalization as necessary, desirable and inevitable in interpretive research (e.g., Williams, 2001; Golden-Biddle and Locke, 1993; Mason, 2002). In arguing for the need to pay attention to generalization, Williams (2001) observed:

> *If interpretivism is to be of any use at all in social policy formulation or evaluation, it must be able to say something authoritative about instances beyond the specific ones of the research. Generalization is both necessary and inevitable in interpretive research. Without it interpretivism is art and whilst art is a laudable activity, it is inadequate as a basis for policy action and for claims about what the wider social world is like.*

However, unlike positivist/quantitative research, where the aim is statistical or universal generalization, interpretive research seeks to deliver analytic generalization (Walsham, 1995), also variously known as naturalistic generalization (Lincoln and Guba, 1985); petite generalization (Stake, 1995) or moderatum generalization (Williams, 2000). In interpretive research, generalization is about cases in a similar context (Stake, 1995; Lincoln and Guba, 1985; Guba and Lincoln, 1989). Therefore, delineating the boundary of cases assumes importance. Analytic generalization seeks to establish theoretical linkages between aspects of various case studies and to a population that share similar contexts (Macpherson, Brooker, and Ainsworth, 2000; Walsham, 1995). According to Macpherson, *et. al.* (2000):

> *The issue of generalization in case studies is not one of statistical inference, as it is with positivist research, but with establishing theoretical linkages between aspects of various case studies. The validity of extrapolation depends on the typicality or representativeness of the case but upon the cogency of the theoretical*

> *reasoning…and that case studies may be used analytically … (only) if they are embedded in an appropriate theoretical framework. It is the richness of the detail provided by a well conducted case that develops insights that have resonance in other social settings, thereby, allowing theoretical connections to be explored and established.*

Analytic generalization or moderatum generalization serves as the bridge between the ideographic and the nomothetic (Williams, 2001). It does not reduce the importance of internal validity but rather places an emphasis on external validity provided alternate explanations have been discredited (Williams, 2005). In interpretive research, generalization may result in development of concepts, generation of theory, derivation of specific implications, and contributions of rich insights (Walsham, 1995).

5.2 CASE STUDY RESEARCH METHOD

In order to operationalize the interpretive research approach discussed in the preceding section, this research utilized the case study research method. Case study research is a time-honored approach for studying topics in organization science and management (Jensen and Rodgers, 2001; Yin, 2003b). The distinguishing characteristic of case study is that it facilitates the examination of a contemporary phenomenon in its real-life context especially when the boundaries between the phenomenon and context are not clearly demarcated (Yin, 1981; Yin, 2003b). Case studies build on reader's tacit knowledge, effectively demonstrate the interplay between the researcher and the respondents, and help acquire a rich understanding of the context, processes, structure and contents (Lincoln and Guba, 1985). Case studies are capable of generating vicarious descriptions (Stake, 1995), uncovering causal paths and mechanisms, and through richness of detail, identifying causal influences and interaction effects that have both relevance and resonance across sites (Jensen and Rodgers, 2001; Macpherson, Brooker, and Ainsworth, 2000; Miles and Huberman, 1994). The case study method is particularly suitable for this research because it concerns a contemporary phenomenon about which little is known, the focus is on understanding the phenomenon in its real-life context, the questions posed are "how" and "why" questions, and the researcher has no control over events (Yin, 2003b).

According to Graham (2000), a case study is like detective work – nothing is disregarded; everything is weighed and sifted and checked and corroborated. However, since context is core in a case study, the design of a case study must cope with the essential problem that there will always be too many 'variables' of interest for the number of observations to be made (Macpherson, Brooker, and Ainsworth, 2000; Yin, 2003b). Therefore, focusing the case and establishing its boundary is crucial for an effective case study design (Yin, 2003a; Yin, 2003b; Eisenhardt, 1989b). Case studies can be of various types (Jensen and Rodgers, 2001). For example, a 'Snapshot Case Study' focuses on detailed, objective study of one research entity at one point in time. 'Longitudinal Case Studies' strive to study one (or many) research entity at multiple time points. A 'Pre-Post Case Study' investigates a research entity at two time points separated by a critical event. A 'Patchwork Case Study' involves a set of multiple case studies of the same research entity using snapshot, longitudinal, and/or pre-post designs. Finally, 'Comparative Case Studies' entail multiple case studies of multiple research entities for the purpose of cross-unit comparison. Case studies can involve numerous levels of analysis and also employ an embedded design, that is, multiple levels of analysis within a single study (Yin, 2003b). Case studies are non-interventive and emphatic (Stake, 1995), and typically combine data collection methods such as archives, interviews, questionnaires, and observations (Yin, 2003b).

This research employed a multiple case study strategy with an interpretive stance. As explained earlier, an interpretive research approach was adjudged to be most appropriate for this study. Interpretive case studies generate thick description and experiential understanding and allow the researcher to capture multiple realities, which, in turn, allows the pursuit of theorizing about complex phenomenon. An ongoing interpretive role of the researcher is prominent in interpretive case studies (Stake, 1995). The next section delineates the specifics of the multiple case study design used to conduct this inquiry.

5.2.1 Multiple Case Study Research Strategy

A multiple case study design is attractive because it permits detection of patterns across classes or clusters to understand complex phenomenon and its dynamics and produces compelling evidence in a robust manner (Stake, 1995; Yin, 2003b). Such a design also facilitates examination of how a phenomenon performs in different settings and environment (Stake, 2006). According to Yin (2003b), a multiple case study design is akin to a series of laboratory experiments, where each successive case serves to replicate the findings of the previous case. Each case in a multiple case study is seen as a distinct analytic unit, and multiple cases are treated as discrete experiments that serve to replicate, contrast or extend the emerging theory (Eisenhardt and Graebner, 2007). Thus, the logic of replication is central to the design of a multiple case study (Yin, 2003b; Eisenhardt, 1989b). Cases could be chosen such that each successive case predicts similar results (literal replication) or produces contradictory results but for predictable reasons (theoretical replication) (Yin, 2003b). However, a fundamental difference between laboratory experiments and a multiple case study is that unlike laboratory experiments, which isolate the phenomena from their context, case studies emphasize the rich, real-world context in which the phenomena occur (Yin, 2003b; Eisenhardt, 1989b).

A multiple case study strategy offers a powerful means to generate a descriptive and explanatory theory because it permits comparison across cases and facilitates replication, extension, and contrasting among individual cases (Eisenhardt, 1991; Pettigrew, 1990). Varied empirical evidence provided by different cases often surface complementary aspects of a phenomenon, and so by piecing together the individual patterns it is possible to generate a holistic understanding and a robust theory (Eisenhardt, 1991; Eisenhardt and Graebner, 2007). The motivation to pursue a multiple case study approach for this research was twofold. First, since a macro-level phenomenon like offshoring of R&D could only be understood by studying its micro-level instances, multiple cases needed to be examined so as to understand the terrain of the phenomenon and its focal aspects. Second, since theory development was one of the key objectives in this study, the outputs of this research must be relevant to a broad cross section of the phenomenon. Thus, comprehensiveness and wider applicability of the research contributions were two key considerations in this study, both of which were achieved by a multiple case study design (Yin, 2003a; Yin, 2003b; Eisenhardt and Graebner, 2007). Usually, 4 to 10 cases are considered effective for deriving full benefit from a multiple-case study research (Eisenhardt, 1989b; Stake, 1995). This research included 8 in-depth case studies.

Since the objective of the research was to generate understanding and theory applicable across the terrain of the phenomenon of offshoring of R&D, the multiple case study design considered both literal and theoretical replication. The research adopted the roadmap proposed by Eisenhardt (1989b) for building theory from multiple case studies. With an inductive logic at its core, the roadmap facilitated theory building from multiple case studies via recursive cycling among the case data, emerging theory, and the extant literature (Eisenhardt, 1989b; Eisenhardt and Graebner, 2007). Such an approach is deemed appropriate when little is known about a phenomenon or when current perspectives either seem inadequate or conflict with each other (Eisenhardt, 1989b). The approach advocated by Eisenhardt (1989b) has been extensively used by organizational scholars in a wide range of studies. However, it has a positivist orientation and, therefore, following (Gioia and Pitre, 1990), this research adapted the approach to align it with the tenets of the interpretivist paradigm. Theory building[1] in the interpretivist paradigm aims to generate descriptions, concepts, insights, and explanations of phenomena so that the systems of interpretation and meaning as well as the underlying structures and processes that influence actions and behaviors are revealed. The basic stance towards theory building is to see the phenomena from the perspectives of the organization members and engage in sense-making (Gioia and

[1] A theory is any coherent description or explanation of observed or experienced phenomena, and theory building refers to the process by which such representations are generated, tested, and refined (Gioia and Pitre, 1990).

Pitre, 1990). In keeping with the spirit of an interpretive approach, this study used a flexible research design to conduct the case studies to accommodate emergent insights from data while keeping the research objectives intact (Yin, 2003b). Such a design was necessary to evolve understanding through the inductive process, given the aims of this research.

5.2.2 Role of Theory in Multiple Case Study Design

Before proceeding to discuss the remaining aspects of the multiple case study design and its execution, a discussion on the use of theory in inductive, interpretive research is necessary to clarify the approach and position adopted in this research. The realm of research methodology is replete with considerable debate concerning the use of existing theory in inductive, interpretive research. Opinions are divided on whether the use of *a priori* theory or conceptual framework is appropriate in the conduct of an interpretive inquiry. While some scholars consider use of theory or theoretical notions as adherence to an inappropriate paradigm (e.g., Lincoln and Guba, 1985; Graham, 2000), others argue that it is not possible to conduct a study without some pre-existing theoretical ideas or assumptions (e.g., Mason, 2002; Robson, 2002; Suddaby, 2006). According to Mason (2002), "Certainly the idea that theory can ever come last has been much criticized, since in its most naïve form this appears to assume that research can be begun and undertaken in a theoretical vacuum." Suddaby (2006) also makes a similar observation: "Leaving aside the question of whether it is even possible to disregard one's prior knowledge and experience, the idea that reasonable research can be conducted without a clear research question and absent theory defies logic."

As a result of such divided opinions, much confusion prevails on how to view the role of theory in the conduct of an interpretive inquiry. On one hand, pre-ordained theoretical perspectives can have a potentially deforming effect since they can bias or limit the findings, and can induce the researcher into testing hypothesis rather than engaging in sense-making in the field (Becker and Richards, 1989; Eisenhardt, 1989b; Suddaby, 2006). On the other hand, achieving the ideal of clean theoretical slate may be impossible (Eisenhardt, 1989b). Consistent with Strauss and Corbin (1998), this research adopts the view that not only theory and existing literature are useful in various ways across the stages of an inquiry, and concurs with the assertion made by many scholars that it is not possible to approach an empirical setting without 'some' theory (Pettigrew, 1990). This is because a researcher's interest and research focus are essentially shaped by his/her prior knowledge, conceptions, beliefs and experiences, and that he/she inevitably brings a certain "worldview" to the conduct of inquiry (Lincoln and Guba, 1985). Also, practically it seems infeasible to enter a research site without 'a' or 'some' theory because otherwise the data collection cannot be 'directed.' The *real* issue, therefore, is not whether theory should be used but what really constitutes an appropriate manner of use of theory in interpretive research.

In his analysis of the advantages and disadvantages of use of theory, Maxwell (1996) opines that not using existing theories enough or relying too heavily on them can either compromise the research outcome(s) and recommended that theory be treated as “coat closet” or as “spotlight.” Others have similarly proposed that use of theory should be viewed as a kaleidoscope (Silverman, 2000) or temporary “walking sticks” (Roethlisberger, 1977). Consistent with these suggestions, following Walsham (1995, 2006), this research treated the use of theory as a “scaffold,” where the scaffolding was removed once it had served its purpose. Informed and critical use of theory in this way provided a valuable guide to empirical research. Therefore, the conceptual lens developed in Chapter 4 formed an essential part of the research design (Yin, 2003b) but was refined based on the emergent insights, as the inquiry moved from case to case. The conceptual lens aided the process of case selection, provided guidance for directing efforts during data collection, and also served as a template for data analysis. The conceptual lens was also instrumental in binding the multiple cases together (Stake, 1995). The research proceeded with the conceptual lens providing a tentative theory about the focal aspects of the phenomenon, which was progressively refined through inductive analysis in an iterative and interactive fashion. Also, instead of adhering exclusively to a single theory, I drew upon several theoretical perspectives that closely related to the focal aspects of this research (Dobson, 1999; Suddaby, 2006; Walsham, 1995). The use and juxtaposition of alternate theories and their relative explanatory powers helped strengthen the ultimate conclusions reached (Van Den Ven and Poole, 1989).

5.3 UNIT OF ANALYSIS

The unit of analysis defines what the ‘case’ is and determines the boundary of a study (Yin, 2003b). A ‘case’ is a unit of human activity embedded in the real world, which can only be studied or understood in its real-life context since it is difficult to isolate it from its context (Graham, 2000). Another significance of unit of analysis is that it permits comparison across cases. Therefore, defining the unit of analysis assumes critical importance in case study research (Yin, 2003a; Yin, 2003b). The unit of analysis for this study was ‘Offshore R&D Engagement.’ An ‘engagement’ essentially denotes a relationship dyad involving two ‘actors’. Organization of offshoring of R&D involves two ‘actors’ who are located in two different countries and who often act in different capacities to achieve R&D objectives. As the literature review suggested (see Chapter 2), an offshore R&D engagement can be modeled as a principal—agent relationship, where the principal (actor one) ‘engages’ or involves the agent (the second actor), who is located in a different country, to perform certain R&D tasks or deliver pre-defined R&D objectives. Since offshoring of R&D is enacted through a dyadic relationship, it was appropriate to treat an offshore R&D engagement as the unit of analysis. This also permitted/required obtaining perspectives from both the parties in the dyad (i.e., the ‘principal’ and ‘agent’), which was crucial for acquiring a holistic understanding about the phenomenon and its focal aspects. The scope of an offshore R&D engagement can vary from a single R&D program to multiple R&D programs. So, wherever applicable, an R&D program was considered as an embedded unit of analysis.

5.4 SAMPLING STRATEGY AND CASE SELECTION CRITERIA

In adopting a multiple case study design, the objective of the research was to understand in-depth how firms leverage offshoring of R&D for innovative capability and organizational flexibility. The analytical aim was to compare the cases to not only excavate patterns of similarities and differences across offshore R&D engagements but also juxtapose these to sculpt a theory that can explain the link between offshoring of R&D and firm innovative capability and organizational flexibility. As is apparent from the statement of objectives, the intended contributions of this study are at the level of firm. Thus, it was imperative to ensure that the chosen cases were relevant to the focus of the study and also provided diversity across contexts (Stake, 2006). In keeping with the spirit of interpretive research, a purposive sampling strategy aimed at achieving maximum variation was employed for selection of case study sites. In purposive sampling, the theoretical relevance of a case assumes significance, and the objective is to systematically select cases for reasons of replication, contradiction, and alternative insights (Lincoln and Guba, 1985; Eisenhardt, 1989b; Pettigrew, 1990; Walsham, 1995).

In order to aid the process of purposive sampling, the study used four criteria for selection of cases: high technology industry, software R&D, tenure (duration) of offshore R&D engagement, and size of offshore R&D engagement. First, innovation and flexibility are crucial for competitiveness of high technology firms, so presumably their R&D offshoring engagements would provide rich grounds for investigating the focal aspects of this research. Second, amongst other areas, software R&D has witnessed an unprecedented propensity towards offshoring, implying its importance. Because software systems are modular, partitioning and distributing software R&D work is easier when compared to other areas. The propensity towards offshoring of software R&D can be attributed to its modular characteristic. Another reason for the propensity towards offshoring of software R&D is that since software is a digital product, it does not need to be transported physically; it can be easily and instantaneously transported via electronic networks. Also, software R&D process differs from other technology R&D in that there is no tooling or manufacturing phase of product development; rather when R&D is finished, the program is ready to copy, ship and use (Tessler and Barr, 1997). This makes studying software R&D particularly interesting. Also, in high technology industries, software is becoming a dominant part of the overall R&D activities and consuming a big chunk of the total R&D budget (Goldstein and Hira, 2004). Third, the tenure of an offshore R&D engagement is an important factor to consider because strategic dimensions such as innovation and flexibility begin to play out only after the engagement has attained some level of maturity. Finally, the size of an offshore R&D engagement assumes importance because a certain critical mass is indicative of the intent to leverage offshoring of R&D for innovative capability. Based on inputs from experts, this research considered only those offshore R&D engagements that were active and had achieved a tenure of at least two years with a size of minimum 50 R&D staff at the offshore location.

Based on a detailed perusal of published information as well as information obtained through the researcher's own professional network, a population of intra-firm and inter-firm offshore R&D engagements was identified. This population included 17 India-based intra- and inter-firm offshore R&D engagements, and each member of the population conformed to the case selection criteria discussed above. The search for suitable offshore R&D engagements located in India was primarily driven by two reasons: India's emergence as top R&D offshoring destination, and ease of access since the researcher was based in India and had contacts in the local industry. From this population, access to 8 offshore R&D engagements was secured for in-depth case studies ensuring variation across sectors within high technology industry, type of software R&D work, tenure of the offshore R&D engagements, size of offshore R&D engagement, and the mode of offshoring. Since the objective of this research was to produce theory that would be widely applicable, both literal and theoretical replication was necessary (Leonard-Barton, 1990; Yin, 2003b). Thus, the cases were selected for their similarities as well as their differences (Eisenhardt, 1989b; Pettigrew, 1990; Van De Ven and Huber, 1990). The substantive area addressed in this research – the offshoring of R&D – was similar across cases as it was expected that this would likely replicate or extend the emergent theory. Similarly, all offshore R&D engagements chosen were focused on software R&D, and in each engagement the firm that offshored R&D was in high technology business.

However, since a key aim of the research was to generate a theory with wider resonance and the potential to inform managerial practice, the case selection purposefully sought to choose offshore R&D engagements with varied organizational contexts and a wide range of software R&D work. Table 5.2 provides information on the eight case study candidates that resulted from the purposive sampling exercise. As is evident, the cases differed in terms of industry contexts, firm headquarters location, and size as well as tenure of offshore R&D engagements. Moreover, while all cases pertained to offshoring of software R&D, their organizing mode differed (intra-firm offshore R&D versus inter-firm offshore R&D). Thus, while the substantive area, i.e., offshoring of software R&D was common across cases and the cases were purposefully selected because of their potential to inform the focal aspects under study, they also differed from each other in many respects so as to allow sufficient variation. Such

Table 5.2: Case Study Samples of Offshore R&D Engagements

Industry	H.Q. Location	Location of the Offshore R&D Unit	Type of Offshoring	Tenure of Offshore R&D Engagement[1]	Size of Offshore R&D Engagement (# of R&D Staff)[2]	# of Interviews
Enterprise Software Products	North America	India	Intra-firm	11 years	900	20
Enterprise Software Products	Europe	India	Intra-firm	7 years	3000	11
Enterprise Software Products	Europe	India	Intra-firm	4 years	300	9
Consumer Electronics	Europe	India	Intra-Firm	10 years	600	7
Medical Systems	Europe	India	Intra-Firm	8 years	300	11
Semiconductors	North America	India	Inter-Firm	8 years	330	10
Media & Entertainment Products	North America	India	Inter-Firm	5 years	60	11
Security & Surveillance Products	North America	India	Inter-Firm	2 years	50	6

[1] Data as of the dates of my visit to the respective case study sites. All of the offshore R&D engagements studied were current.
[2] Data as of the dates of my visit to the respective case study sites

variations permit useful contrasts across cases and can surface contradictions that help elaborate the emerging concepts and contribute to the generation of a well-rounded theory (Lincoln and Guba, 1985; Eisenhardt, 1989b, Pettigrew, 1990). Finally, it is important to mention an important point here. Precisely because of the nature of software development, which is a highly intangible innovation activity, identifying its components that can be classified as 'R&D' can be challenging (OECD, 2002). This research adopted the guidelines provided in the Frascati Manual (OECD, 2002) for identifying software R&D activities.

5.5 DATA GATHERING

Data gathering involved securing access to case study sites; deciding what data to collect, from whom and how; and actually collecting data. Basically, the data gathering phase may be viewed as consisting of two tracks. One track entailed determining the data collection approach and the method, and the second one involved securing access, visiting sites and gathering data. This section discusses the data gathering phase of the research in detail.

5.5.1 Approach and Method for Data Collection

In the interpretivist tradition of research, the aim of inquiry is to interpret a social or organizational phenomenon to produce a rich understanding of the complex meaning structures that social actors construct in their specific organizational environments (Denzin and Lincoln, 1998). In other words, an interpretive research seeks to construct an understanding of meanings, processes and structures, and norms that guide interaction, practices, and motivations (Macpherson, Brooker, and Ainsworth, 2000). This means that the interpretive approach views people and their interpretations, perceptions, meanings, and understandings as the primary data sources (Mason, 2002). The attempt, therefore, is to understand not one, but multiple realities and the emphasis is on utilizing tacit knowledge (intuitive and felt knowledge) (Lincoln and Guba, 1985). In interpretive research, researcher is the primary instrument, and interviews are the dominant methods, for data collection since it is through interviews that one can best access informants' interpretations regarding the actions and events (Walsham, 1995).

Interviews come naturally to the human-as-instrument because human-as-instrument resonates well with methods that are extensions of normal human activity like listening, speaking, reading, etc. The human-as-the-instrument also has certain benefits like responsiveness, adaptability, and the ability to clarify and explore atypical or idiosyncratic responses (Lincoln and Guba, 1985). Interviews are particularly appropriate when the focus of study is on the meaning of particular phenomenon to the informants/participants and where individual perceptions of a process or phenomenon are to be studied in an organizational context (Robson, 2002). Thus, this research used interviews as the primary method for data collection, which did not require 'total immersion in the settings' (Mason, 2002). Also, due to the absence of prior knowledge on the focal aspects of the phenomenon, conducting interviews was the only choice available to develop understanding, which was also grounded in empirical reality (Mason, 2002; Eisenhardt and Graebner, 2007; Walsham, 1995).

In keeping with the tenets of interpretive approach, this research employed qualitative interviewing, which essentially involves an interactional exchange of dialogue and employ a relatively informal style much like that in a discussion. The research used semi-structured informant interviews with open-ended questions for gathering data. A semi-structured interview is a thematic, topic-centered interview with a scripted set of open-ended questions, but is fluid and flexible in its approach (Mason, 2002; Robson, 2002). This means that in semi-structured interviews the order in which questions are posed can be modified based upon interviewer's perception of what seems most appropriate as well as additional questions can be included depending on how the interviews unfold (Gillham, 2000; Robson, 2002). Viewed in this sense, qualitative interviews are essentially 'conversations with a purpose,' which generate qualitative data (Robson, 2002). Interviews can be done face-to-face or by telephone, can be one-on-one or a group of people may be interviewed together (Gillham, 2000; Silverman, 2000).

In order to conduct the interviews, two interview guides were developed—one for the informants at the offshore R&D organizations and another for informants located overseas at the company headquarters. Both of these interview guides contained open-ended, semi-structured questions along the same dimensions of inquiry but differed in their orientations as the aim was to obtain perspectives from both the parties in the offshore R&D engagement dyads. Table 5.3 shows the dimensions of the inquiry that were used to develop the interview guides. These dimensions of inquiry were based on the conceptual lens. The interview guides were piloted with experts in the industry before being deployed for data gathering at the case study sites. Besides assessing their effectiveness, another purpose behind piloting the interview guides was to practice and hone active listening skills. The interview guides evolved during the course of the study as I gained experience with interviews and as concepts and theory emerged from data resulting from successive cases. Both the interview guides included suitable probes and prompts to establish details. Appendix II presents both the interview guides.

Interviews sought to collect data related to context, structure, processes, antecedents and consequences, and also looked for competing versions of reality in offshore R&D engagements (Pettigrew, 1990). Interviews also aimed to gather historical data by studying the evolution of offshore R&D engagements since their commencement. Such historical perspectives help sharpen one's vision of the present and often provide

Table 5.3: Dimensions Guiding the Inquiry and Their Descriptions

Dimensions	Descriptions
Context and Background of the Offshore R&D Engagement	• Motivations for Offshoring of R&D • Actors in the Engagement • Mode and Size of the Engagement • Beginning and Evolution of the Engagement
Organization and Management of the Offshore R&D Engagement	
Structural Dimensions	• Governance Structure • Coordination Mechanisms
Relational Dimensions	Quality and Dynamics of the Relationship • Trust, Credibility, Procedural Justice • Distance (Geographical, Time Zone, Cultural)
Engagement Model	• Approach for Engaging the Offshore R&D Organization • Practices and Considerations for Allocation of R&D Tasks to the Offshore R&D Organization
Firm Innovative Capability and Offshore R&D Engagement	• Innovations Generated by the Offshore R&D Organization and the Organizational Attributes Associated with the Innovation • Type/Stock of Knowledge at the Offshore R&D Organization • Processes and Mechanisms for Knowledge Transfer and Integration from the Offshore R&D Organization to the Firm Headquarters; Also, Determinants of Knowledge Transfer and Integration
Organizational Flexibility and Offshore R&D Engagement	• Firm's Need for Organizational Flexibility • Types of Organizational Flexibility Contributed by the Offshore R&D Organization • Organizational Processes Used by the Firm to Leverage Offshoring of R&D for Organizational Flexibility

alternative explanations for phenomena (Lawrence, 1984).[1] All the interviews were recorded using a digital voice recorder. Tape recording interviews have their own merits and demerits. Using a tape recorder can potentially result in respondent inhibition to sensitive matters; it also involves considerable transcription labor and can

[1] "Historical perspective refers to understanding a subject in light of its earliest phases and subsequent evolution. This perspective differs from history because its object is to sharpen one's vision of the present, not the past" (Lawrence, 1984).

cause distraction to informants as well as the researcher (Walsham, 1995; Walsham, 2006). However, in this research, all the interviews were recorded because the advantages appeared to far outweigh the disadvantages. Specifically, recording the interviews resulted in a complete account that, in turn, (a) guarded against being selective, (b) allowed the researcher to playback the recording and 'relive' the conversation, (c) prevented the researcher from being distracted from active listening, and (d) served as an audit trail (Gillham, 2000; Walsham, 1995).

One more aspect needed a careful consideration – the selection of informants. Since the offshore R&D engagements were enacted by two geographically separated actors, obtaining perspectives from informants from both the sides, and at multiple levels, was necessary to understand all the interacting factors and to acquire a balanced perspective (Leonard-Barton, 1990). It was clear that the most appropriate informants at the headquarters locations would be those senior managerial and technical people who were directly and closely involved with the offshore R&D engagement. As for informants at the offshore R&D organizations, people from different levels of hierarchy, going down to the third level, were interviewed and included both managerial and technical people. Thus, in all the case studies, the selection of the informants sought to maximize the variety of profiles and heterogeneity of perspectives. In addition, only those informants who had been associated with the offshore R&D engagement for at least 24 months were interviewed so as to be able to obtain longitudinal perspectives. Such selection of numerous and knowledgeable informants, who view the phenomenon and its focal aspects from diverse perspectives, helped produce rich and holistic perspectives, revealed the complete structural and processual pattern, and limited key informant bias (Eisenhardt and Graebner, 2007; Leonard-Barton, 1990).

5.5.2 Securing Access, Visiting Case Study Sites, and Collecting Data

As mentioned earlier, a population of 17 offshore R&D engagements that seemed relevant for the focal aspects of the research was defined. Once a 'population' was defined, a formal letter was sent to each of the 17 organizations in India that housed the offshore R&D activities, explaining the significance of the research and requesting their participation. The letter was customized for each organization and clearly specified what was expected of them if they agreed to participate. The letters also enclosed an outline of the research and were addressed to the head of the organization in India that hosted the R&D activity for a foreign firm. Obtaining access was a challenge for me because I myself held a senior management position at a large technology company at that time and a key concern was that many companies that were approached would not be comfortable in giving access due to confidentiality and competitive reasons. In order to alleviate any such concern, the letter of request for access specifically: (a) stated that the request for access was purely in my personal capacity for doctoral research, (b) offered to sign a non-disclosure agreement with the companies so as to heighten their confidence in my ability to protect their business interests, and (c) assured that no proprietary or confidential information that I may come across during the course of my interaction with them would be divulged.

The letters sent to the target companies clearly mentioned that a draft of the case write-up would be sent to them for review and approval, and while any factual corrections or additional perspectives that might enrich the case would be incorporated, I won't be obligated to change my interpretations in the case report. However, the letter did include a provision for the participating companies to request anonymity if that would be a must for whatsoever reason. Also, very importantly, the letters stated that granting access would require the companies to arrange for me to be able to speak to relevant people from both the parties in engagement dyad – people at the offshore R&D organization and the overseas entity that offshored R&D. This was absolutely necessary because, as implied by the research questions, the level of analysis in this study is the firm. So, even though the phenomenon took place at the offshore R&D organizations, obtaining perspectives from people at the firm headquarters was crucial so as to be able to acquire complete and balanced perspectives.

Of the 17 companies that were approached with requests for access, 11 responded favorably, 4 regretted their inability to participate primarily due to confidentiality and competitive reasons, and 2 did not respond despite follow-ups. Of the 11 that agreed to participate, 8 were finally chosen (see Table 5.2 for details) for this research on grounds of greater relevance and variety that they offered. For each of the eight offshore R&D engagements, a single point of contact at the offshore R&D site was established with plans for site visit, interview schedules, and access to information and clearances were coordinated. These single points of contact served as guides into the organization. Before visiting the sites, basic information from the participating organizations about the offshore R&D engagement was obtained using a structured template. The information requested included: the names and locations of the organizations that formed the offshore R&D engagement dyad, the date of commencement of the offshore R&D engagement, number of R&D staff at the offshore R&D site, basic information on the kind of offshore R&D work, etc.

Informants for data gathering interviews at each site were identified with the help of the points of contact. Wherever an offshore R&D engagement included multiple programs, first the specific R&D programs that appeared relevant for the study were determined and then the informants were identified. The identification of informants was based on the criteria discussed in the preceding section. Once the informants from both the offshore R&D site as well as the overseas location were identified, a visit was made to each of the offshore R&D sites to brief the informants about objectives of the research and answer any questions they might have. At these briefing sessions, clarifications were provided on the nature of the interviews, how would they be typically conducted, and how the data obtained would be used (Gillham, 2000). As for the informants based overseas (outside of India), a communiqué was sent via email and later followed-up with a telephone call to clarify any specific matter. The brief/communiqué to the informants also clearly mentioned that the interviews would be recorded so as to capture every bit of the conversations, and explicitly sought their consent for the same. Informants were explicitly assured that all individual conversations would be held strictly confidential at all times, and that their identity would not be disclosed if they so desired. In some cases, the informants wanted to get a feel for the kind of questions that would be posed to them during the actual interview, so the appropriate interview guide was shared with them.

Working with the points of contact, an interview schedule was drawn up for each case study site. The visits to the case study sites were planned sequentially during June 2005 and January 2007 for the actual data collection (interviews). Multiple visits were made to some of the case study sites twice, either to interview a set of informants that belonged to a different business/R&D group or to do follow-up interviews to clarify or acquire additional perspectives. All interviews at the offshore R&D organization were done face to face, whereas for logistical and cost reasons most of the interviews with informants located overseas were done by telephone. Although many scholars argue that telephone interviews are usually not as effective as face-to-face interviews (e.g., Gillham, 2000), telephone interviews served the purpose of this research well. Given the substantive areas of focus in this research, and considering the nature of the interview questions, the main focus in interviewing was to elicit informants' perspectives by engaging them in a purposeful conversation and so immersion in the setting was not required. Moreover, attention to non-verbal behavior was not critical for this research (Sturges and Hanrahan, 2004). Therefore, telephone interviews provided a level of effectiveness similar to that of face-to-face interviews. This is consistent with Sturges and Hanrahan (2004), who in a study comparing face-to-face interviewing with telephone interviewing concluded that telephone interviews could be used productively in qualitative research. All interviews were done in English.

As mentioned earlier, the interview guide used for informants located overseas differed from that used for the informants at the offshore R&D organizations. The main difference between the interview guides was in their orientation of the questions; the dimensions of inquiry were common in both (Nohria and Ghoshal, 1997). All the interviews were fully recorded using a digital voice recorder. In addition, detailed notes were made during each interview to capture the salient points as well as note pointers for any follow-up questions. Each interview lasted for about an hour and ten minutes on an average, although some went on for nearly two-and-a-half hours. Each interview began with exchanging pleasantries followed by a quick overview of the objectives of the research. It was also clarified to the informants that there was no right or wrong answer, and that the main interest was to obtain their perspectives on the offshore R&D engagement and its focal aspects in the specific organizational context that they were operating in. Before proceeding with the actual conversations, the consent of the informants to record the interview was obtained again. Also, they were assured that full confidentiality would be maintained at all times and that their individual identity would never be disclosed to anyone. Depending on the how conversations developed during the interviews, real-time decisions to trade-off ‘depth’ for informational ‘breadth,’ and vice versa, were made. This allowed full leverage of the semi-structured interview method that the research used and generated rich yet varied perspectives.

During the interviews, a conscious effort was made to listen to the informants actively and in a non-judgmental fashion (Walsham, 1995). Also, the questions to the informants were posed in a layman’s language, in a clear and straight-forward manner, carefully avoiding use of any jargon or the researcher’s “native” language. Special care was taken not to ask any leading questions or provide any clues that might lead respondents to answer in any particular way (Mason, 2002; Robson, 2002). However, whenever the informants asked, clarifications were provided by elaborating the questions. While interviewing the informants, prompts and probes were used to establish details and extract deeper perspectives. Clarifications, justifications, reasoning and examples were asked for to not only acquire well-rounded perspectives but also to keep the interviewees honest (Gillham, 2000; Brown and Eisenhardt, 1997). Sometimes, a deliberate attempt was made to incorrectly paraphrase what the informants said to check if their stories were consistent, and on some occasions the informants were ‘challenged” to elicit additional perspectives. While the interviews served as the primary data sources, published information on the firms studied were also used as the secondary sources of data for the case studies. Most of these data were obtained from the company Web sites, newspapers and business magazines. In addition, some of the participating companies also provided additional information and internal documents for the purpose of this research.

5.6 DATA ANALYSIS

This section describes how the collected data was analyzed, including the approach to, and the techniques used for, data analysis. However, before that, some discussion on the process of interpretation itself is necessary to understand how data are processed and analyzed in interpretive research to evolve understanding and build explanations. An interpretive researcher is primarily concerned with understanding the social world people produce and re-shape through their continuing activities. The everyday organizational reality consists of the meanings and interpretations given by the actors to their actions, other people’s actions, and various organizational situations. Thus, in order to negotiate their way around and make sense of it, organizational actors have to interpret their activities together, and it is these meanings that arise out of interpretation, embedded in language, that constitute their organizational reality. Therefore, at its core, interpretation is essentially the work of thought which involves deciphering hidden meanings in the apparent meanings, in unfolding the levels of meanings implied in the literal meanings, to make sense of the organizational reality (Blaikie, 2000).

Drawn from hermeneutics, the concepts of "pre-understanding" and "understanding" are central to the process of interpretation. "Pre-understanding" is the fusion of knowledge, experience, and the worldview that individuals bring to any organizational situation, whereas "understanding" refers to the knowledge and insight that the researcher develops during the research process. Interpretivism believes that researchers cannot start *tabula rasa*, meaning they always have some conception and initial interpretation of the organizational phenomenon that they bring to the inquiry. Thus, the sum of knowledge, experiences, notions and conceptions that the researcher brings to the inquiry is considered as his or her pre-understanding (Gummessn, 1991; Weber, 2004). The conceptual lens developed in Chapter 4 provides the pre-understanding for this research. In the interpretive process, the understanding gained serves as the pre-understanding for the successive rounds of seeking new understanding. Thus, the process of interpretation is an iterative and interactive process, known as the "hermeneutic circle." As per the hermeneutic maxim, no "understanding" is possible without some "pre-understanding" (Gummessn, 1991; Gioia and Pitre, 1990; Lee and Baskerville, 2003).

The pre-understanding of the organizational members, also known as the first-level of understanding or subjective understanding, is the 'facts' of an investigation as recalled by the organizational members and includes the interpretations used by them to account for a given situation or phenomenon. Therefore, the first-level understanding refers to the understanding held by the informants themselves. The second level understanding, known as the interpretive understanding, refers to the understanding developed by the researcher and is characterized by those notions that the researcher uses to explain the first level understanding (Lee and Baskerville, 2003). Thus, the second level understanding is the researcher's interpretation of other people's interpretation (Walsham, 1995). Depending on the research objective, an interpretive research can include a third level of understanding, defined in this research as analytic or representational understanding, which essentially involves an interpretive synthesis (Denzin, 1989) arrived at by the researcher by juxtaposing similarities and dissimilarities from across the cases. Construction of this third level of understanding goes beyond the direct interpretation of the individual cases and involves aggregation of cases until something can be said about them as a class (Stake, 1995)

In this study, data analysis took place simultaneously with data collection and the emergent theory in a dialectical process, which is quite typical of inductive, interpretive research. As the study progressed from the initial case to the successive cases, the conceptual lens was refined with emergent insights and that, in turn, facilitated data analysis (Mason, 2002; Blaikie, 2000; Maxwell, 1996). According to the tenets of interpretive paradigm, this research involved three levels of data analysis as shown in Figure 5.1, where each level interacted with and influenced its adjoining level(s). Since this study utilized a multiple case study design, data analysis was done in three separate phases corresponding to the three levels of understanding – analyzing individual interviews, within case analysis, and cross-case analysis. In what follows, the data analysis phase of this research is described.

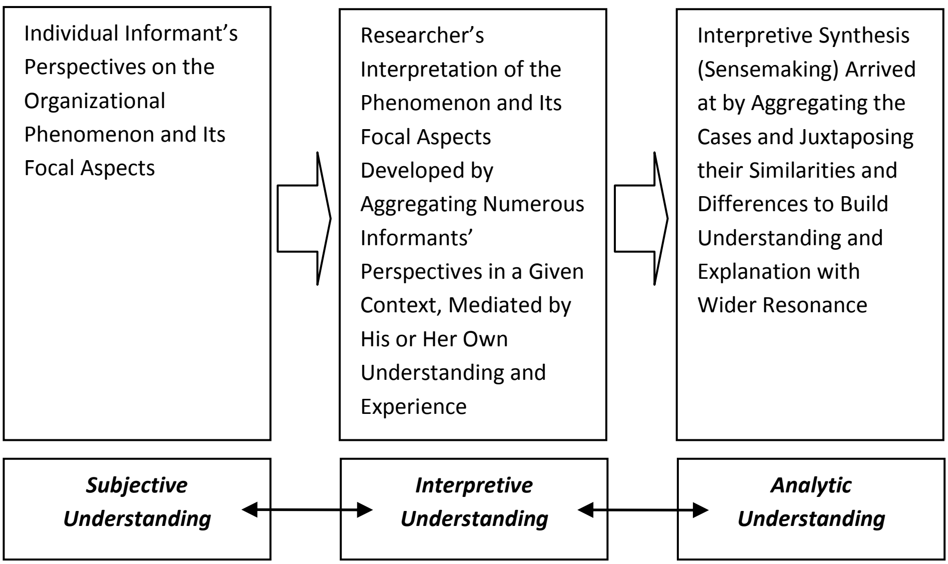


Figure 5.1: The Interpretive Process of Building Understanding and Explanation

To start with, a case study database was designed using MS-Excel spreadsheet, which had a provision to capture the key insights and themes from each interview along all the dimensions of inquiry of interest for every case study (Yin, 2003b). During the interviews notes were made to capture impressions from the conversations, and soon after the interview the key points, along with other relevant inputs, were entered in the case study database (Miles and Huberman, 1984). At the end of each day of interview, the case study database was updated based on the notes and reflections on the conversations (Eisenhardt, 1989b; Brown and Eisenhardt, 1997). After every day of interview, as well as between site visits, a number of memos were written to reflect on the impressions acquired from the case study sites and to develop conceptual ideas

(Maxwell, 1996). Also, since each interview was recorded using a digital voice recorder, I carefully listened to the interviews and oftentimes, utilizing the features of the digital device, listened to specific portions of the conversations for substantive contents before formally embarking on the extensive data analysis phase.

The formal data analysis phase began after completing all the planned interviews at the various case study sites. The process began with transcription of the interviews. Transcription is a pivotal aspect of an interpretive inquiry and facilitates analysis of language data (Lapadat and Lindsay, 1999; Oliver, *et. al.*, 2005). All recorded interviews were transcribed verbatim exactly in the same flow in which the conversations actually took place. Transcription is a time consuming and laborious process (Walsham, 1995) but omitting transcription impacts completeness and accuracy. Also, "transcripts facilitate audits of analytical decision points because they preserve the data in a more permanent, retrievable, examinable, and flexible manner." The process of transcribing also promotes familiarity with the data, which catalyzes theoretical thinking essential to interpretation (Walsham, 1995; Lapadat, 2000). Given the focal aspects of the inquiry, a "de-naturalism" approach of transcription was adopted (Oliver, Serovich, and Mason, 2005). In a "de-naturalism" approach, the main interest is in the informational content and the focus is on meanings and perceptions within speech that construct the organizational reality. In this approach, verbatim depiction of speech is aimed at full and faithful transcription but accuracy here concerns the substance of the interview as opposed to grammar, accent, behavior or background noise (Oliver, Serovich, and Mason, 2005). While transcribing the interviews, the transcripts were coded and marked-up with interpretations in the margin of the document (Lapadat, 2000).

Once all the interviews were transcribed, the task of within-case analysis was methodically undertaken. The term 'methodically' is used here to distinguish within-case analysis from the ongoing analysis of case data that took place during the data collection phase. In order to perform within-case analysis for individual case studies, informants' perspectives related to each dimension of the inquiry for every case study were consolidated. Then, using the consolidated data pertaining to every dimension of interest, detailed case studies were written-up to ensure thick description and a vivid portrayal of multiple organizational realities (Brown and Eisenhardt, 1997; Lincoln and Guba, 1985). Thick descriptions are considered central to the generation of insights and help the researcher to cope with enormous volume of data (Eisenhardt, 1989b). This process involved moving back and forth between data and emerging constructions of the organizational reality for each case. The secondary data obtained from companies and their Web sites as well as from public sources were included as background information for the case study reports. Although similarities and dissimilarities between the cases started to surface, a formal analysis was deferred until the all case study reports had been completed.

The next step in within-case analysis process involved interpretively analyzing the individual cases to develop situational understanding and explanation of the two main research questions (the "How" questions) for each case (Brown and Eisenhardt, 1997). Towards this, the analysis first sought to locate common themes across individual case study data and explore plausible relationship between them (Eisenhardt, 1989b; Miles and Huberman, 1994; Yin, 2003b). For this purpose, thematic analysis was used to identify common themes and conceptual ideas as well as relationships among them (Trochim, 2001; Miles and Huberman, 1994; Berg, 1995; Pettigrew, 1990).[2] Next, using the understanding derived from thematic analysis, a focused explanation building (Yin, 2003b) exercise was performed to answer the two main "How" questions for the individual cases. The conceptual lens described in Chapter 4 was used to aid the interpretive analysis of individual cases but never imposed (Gioia and Pitre, 1990; Brown and Eisenhardt, 1997; Pettigrew, 1990). Within case analyses produced conceptual understanding for the individual cases and served to refine the conceptual lens for the successive cases.[3]

After completing the within-cases analysis for all cases, the cross-case analysis was taken-up. A cross-case analysis is essentially a search for patterns across cases and an attempt to present aggregate findings that potentially have wider appeal (Miles and Huberman, 1994; Yin, 2003b). In doing the cross-case analysis, the aim was to generate understanding and explanation with wider applicability – beyond the individual contexts of the cases studied (Eisenhardt, 1989b; Stake, 2006; Yin, 2003a; Yin, 2003b). The inputs for the cross-cases analysis were the outputs of the within-case analyses. The cross-case analysis entailed comparing individual cases for similarities and differences to develop a meta-understanding and explanation (Yin, 2003b), as well as to spot the outliers (Miles and Huberman, 1994) and to understand the unique aspects of each case (Stake, 2006). To perform cross-case analysis, a thematically ordered tabular display was constructed (Miles and Huberman, 1994), which juxtaposed the similarities and differences from across the cases to facilitate the

---

[2] "Thematic analysis is a systematic process of categorizing the content of text and identifying relationships among the categories. It is useful when attempting to make sense of large amounts of textual data" (Berg, 1995). Thematic analysis helps identify analytical themes that cut across the data (Pettigrew, 1990).

[3] As the research moved from case to case, the conceptual lens evolved iteratively. This means that the empirical findings and 'theory' of the case 1 was used to revise the conceptual lens, which was then used to investigate the case 2. Similarly, the findings and 'theory' of the case 2 was used to revise the conceptual lens, which was then used to investigate the case 3, and so on. This does not mean that the conceptual lens used for the different cases was 'different;' instead, a better, improved, conceptual lens was used for the successive case studies. This is analogous to the use of a high resolution magnifying glass, which provides a better 'visibility' and allows people to view things much better.

emergence of new insights and relationships. With this emergent understanding and theory, an attempt was made to answer the two main research questions by using process maps and causal maps (Miles and Huberman, 1994), while checking for their 'fit' for the individual cases. This required to iteratively resolve the tension between the 'global' and the 'local' understanding and explanations. The cross-case analysis was concluded when a generic understanding and explanation emerged that could also satisfactorily illuminate on the individual cases.

The entire data analysis phase was characterized by what Mintzberg (1979) labeled as "detective work" and "creative leap." Akin to detective work, data analysis strove to track down patterns and searched through the phenomenon looking for order, for consistencies, following one lead to another. The "creative leap" was inevitable because as Mintzberg (1979) observed, "there is no one to one correspondence between data and theory. The data do not generate the theory – only researchers do that." To that extent, the creative leap called for what Mills (2000) called "sociological imagination," which involves an attitude of playfulness about the data, rearrangement of disconnected pieces, reclassification of data, comparison across situations, and analyzing extreme situations.

5.7 RESEARCH QUALITY AND VALIDITY

This section discusses the measures taken to address the issues related to research quality and validity. Generally, four criteria are applied for judging the quality of case study research designs. These are: construct validity or objectivity, which concerns correctness of operational measures for concepts being studied; internal validity, which concerns identification of robust causal relationships; external validity, which concerns establishing the domain(s) to which the research findings can be generalized; and reliability, where the main concern is to make transparent the operations of the study so that the study can be repeated (Yin, 2003b). However, these criteria are rooted in the positivist paradigm, and the ontological and epistemological commitments at the heart of interpretive research render the positivistic criteria about research quality and validity somewhat pointless (Prasad and Prasad, 2002). Interpretivism rejects the basic positivistic assumption that there is an external reality independent of human perception of it, and treats the statistical sampling based generalization and true score theory linked reliability typical of the positivist paradigm as inappropriate (Trochim, 2001). Thus, commensurate with its ontological and epistemological assumptions, interpretive research uses the criteria of credibility, transferability, dependability, and confirmability to evaluate research quality and validity (Lincoln and Guba, 1985; Miles and Huberman, 1994; Shenton, 2004; Trochim, 2001).

Credibility essentially concerns believability and attestation by informants (Lincoln and Guba, 1985; Trochim, 2001). Several measures were taken to make sure the study produced results that were credible. To start with, a research design was developed that ensured that the paradigm and methods of inquiry were 'fit' for the purposes of the study. The research approach and methods used in this study are well-recognized and have been extensively used by other scholars for similar research (Shenton, 2004). All the cases were written-up to provide thick, contextually grounded descriptions and were reviewed by the informants at the respective case study sites (Miles and Huberman, 1994; Shenton, 2004). So, member checking was an integral part of the research process not only for feedback on the individual case studies but also for the interpretive synthesis (Lincoln and Guba, 1985; Shenton, 2004). This 'bouncing-off' of the findings with the informants helped ensure the authenticity and credibility of the research (Sandberg, 2005). Data for each case study was obtained from multiple informants at different levels of organizational hierarchy, whereas for the research as a whole the data came from multiple case studies, thus achieving data triangulation at two levels (Lincoln and Guba, 1985; Miles and Huberman, 1994; Shenton, 2004). In addition, the research relied extensively on peer debriefing as well as informants' feedback to ensure that the researcher's own framework was not inadvertently imposed on the inquiry, "pigeonholing" informants' words into it (Lincoln and Guba, 1985; Shenton, 2004). Finally, in order to facilitate any judgment concerning researcher's bias, a detailed description of my own background and experiences has been included in Appendix III (Shenton, 2004).

Dependability is concerned with the reliability of findings (Lincoln and Guba, 1985; Trochim, 2001). To make sure that the process of inquiry was robust and consistent, several steps were taken. First and foremost, a multiple case study design was used, and the conclusions were drawn by investigating several instances of the phenomenon (Lincoln and Guba, 1985). The research design and methodological decisions underwent peer reviews, as also the research findings and interpretations (Miles and Huberman, 1994). The research process and the methods used for the study were also subjected to regular audits by my doctoral advisor and two other colleagues (Lincoln and Guba, 1985). Memos, notes, interview records and transcripts, data analysis artifacts, and communications with informants and participating organizations were archived to permit an end-to-end audit trail (Lincoln and Guba, 1985; Miles and Huberman, 1994). An elaborate case study database was prepared which contained key findings from all the interviews from across the cases with data organized to readily facilitate thematic analysis (Yin, 2003b). For gathering data, interview guides were prepared and piloted, and each interview was recorded and transcribed (Yin, 2003b; Mason, 2002). Thus, the contributions of this research are rooted in a systematic process of empirical inquiry, supported by proven methodologies.

Confirmability refers to corroboration and confirmation of the findings (Lincoln and Guba, 1985; Trochim, 2001). As mentioned earlier, the research relied extensively on peer debriefing as well as informant feedback. All the cases were written-up in detail and were reviewed by the informants at the respective case study sites. So, member checking was an integral part of the research process (Miles and Huberman, 1994; Shenton, 2004). In addition, multiple theoretical perspectives were used for sense-making and drawing conclusions (Miles and Huberman, 1994; Shenton, 2004). To address reactivity, that is, researcher's influence on the informants and their perspectives, precaution was taken during the interviews to not pose any leading questions to avoid "guiding" informants into the researcher's own worldview. Also, assurance of privacy and confidentiality helped keep the informants honest and encouraged them to share perspectives in real-life contexts by providing concrete details (Shenton, 2004; Sandberg, 2005). This was further aided by questioning informants iteratively, revisiting questions during interviews, and purposefully misrepresenting informants' perspectives to check their reactions (Sandberg, 2005). Moreover, in order to alleviate any key informant bias, which might involve retrospective sense-making by image conscious informants, multiple informants from different levels of hierarchy were selected for all the case studies (Lincoln and Guba, 1985; Miles and Huberman, 1994).

Transferability concerns generalizability to other contexts (Lincoln and Guba, 1985; Trochim, 2001). Developing understanding and explanation with wider applicability was a key aim of this research, and so several steps were taken to achieve generalizability. First of all, a multiple case study strategy was chosen to achieve the aim of generalization. Second, all the cases were written up containing thick, contextual descriptions to facilitate comparison with other contexts (Lincoln and Guba, 1985; Shenton, 2004). Third, explicit case selection criteria were used that also defined the scope and boundaries of the cases. Moreover, a purposive sampling strategy was chosen to study theoretically diverse cases to permit generalizability (Miles and Huberman, 1994). Finally, congruence with prior theory and extant literature was sought to aid generalization (Eisenhardt, 1989b; Miles and Huberman, 1994). To ensure that the researcher's own taken-for-granted framework did not distort the findings, a deliberate interpretive voyage was undertaken to search for differences and contradictions across cases by cross-checking interpretation of each offshore R&D engagement using alternative theoretical perspective. The process of cross-checking continued until the most accurate interpretive theory that illuminated on the focal aspects of the study and resonated with the informants was found (Sandberg (2005).

5.8 On Theorizing and Theory Development

Developing a process theory was a key aim of this study as is evident from the two main research questions (Maxwell, 1996; Mohr, 1982). Process theories are critically important in organizational studies (Van Den Ven and Huber, 1990) because often they can effectively explain actual events in organizations when compared to the typical predictions of variance theories (Markus and Robey, 1988). Process theories are especially suitable for studying dynamic phenomena such as organizational learning, innovation and change, and strategic evolution and adaptation (Langley, 1999).[4] The central concern in process theory is to understand how things happen and why they happen in a certain way, often with attention to evolution over time (Mohr, 1982). In contrast to variance theories that explain a phenomenon in terms of relationships among dependent and independent variables (e.g., more of X and more of Y produce more of Z), process theories generate explanations in terms of sequence of actions and events leading to an outcome (e.g., do A and then B to get C) (Mohr, 1982). Therefore, understanding patterns pertaining to events and actions is the key to developing process theory (Langley, 1999).

In this research, process theory building took place by generating descriptions, insights, and explanations of actions and events so that the systems of interpretations and meanings, and the associated structuring and organizing processes, were revealed (Gioia and Pitre, 1990). The numerous informant interviews from across the case study sites yielded significant amount of process data consisting of narratives embodying events, actions, and time (Langley, 1999; Pentland, 1999). Narratives significantly contribute to the analysis of organizational processes because narrative data contain surface features that are very useful for description and can be 'mined' to identify generative mechanisms that drive the process. It is the generative mechanisms beneath the narrative data that provide explanation by describing the process and connecting cause and effect (Pentland, 1999). Therefore, theorizing involved moving from surface observations toward the underlying structures, that is, from description to explanation (Langley, 1999).

This research relied upon the strategies proposed by Langley (1990) to theorize from process data. First, using the narrative strategy, a thick description of every single case study was produced that allowed identification of the surface features. Then, using the alternate template strategy, several alternate interpretations for the focal aspects of the phenomenon under study – essentially the two "How" questions – were developed. The alternate templates were premised on the conceptual lens that guided this study. This process of building alternate interpretations gave rise to several paradoxes that developed due to theoretical tensions. Resolving the paradoxes and negotiating the best

[4] A theory is a set of well-developed concepts that are systematically interrelated through statements of relationship to form a theoretical framework that explains some relevant phenomenon, whereas theorizing refers to the act of constructing from data an explanatory scheme that systematically integrates various concepts through statement of relationship (Strauss and Corbin, 1998). Theory emphasizes the nature of causal relationships, identifying what comes first as well as timing of such events. A strong theory delves into the underlying processes and helps understand the reasons for a particular occurrence or non-occurrence (Sutton and Staw, 1995).

interpretations that satisfactorily explained the two main questions for all the cases resulted in the normative theory that this research sought to develop (Poole and Van de Ven, 1989).[5] The resultant theory was fine-tuned and evaluated for its quality using the criteria—"that's interesting," "that's plausible," "that's obvious," "that's connected," and "that's believable"—proposed by Weick (1989).

5.9 ETHICAL CONSIDERATIONS

Since in interpretive studies people's perspectives and experiences in the context of specific organizational settings are the primary data sources, many ethical considerations assume importance. Organizations that agree to participate in a research study essentially open their doors to the researcher and, therefore, an element of responsibility and ethical conduct on behalf of the researcher is pronounced. This research was no exception and paid particular attention to the ethical aspects involved in the conduct of the inquiry. First of all, the study sought to study offshore R&D engagements at companies that would typically treat my then employer as a competitor. Even though most of the target companies favorably responded to the request for access due to my relationship with their senior executives, I had the delicate task of accomplishing my research objectives while ensuring that neither the interests of the participating companies nor my employer were compromised in any way. Towards this, I formally signed a confidentiality and non-disclosure agreement with both the participating companies and my employer. The letters of request seeking access clearly stated the scope and purpose of the research as well as how the data gathered and the case study reports would be used.

Besides assuring confidentiality, the letters clearly mentioned that a draft of the case study report would be sent to the respective companies for their perusal before being published. Additionally, the letters requesting access mentioned (a) that each interview would be recorded and (b) while the case study report would be shared with the organization for review and feedback, details from any individual interviews would not be disclosed to anyone. Moreover, it was clarified up front with the participating organizations that if felt necessary their identity would be disguised (Walsham, 2006) but I won't have the obligation to change my interpretations, for that would defeat the very purpose of the research. It was also explicitly clarified with the companies early on that by consenting to give me access for the research they were also granting me the right to publish the case study for scholarly purposes (Mason, 2002). During the first

[5] A normative theory provides a statement of causality. It moves beyond statements of correlation to define what causes the outcomes of interest. In building normative theory, researchers categorize the different situations or circumstances in which managers might find themselves. A normative theory that is built upon well-researched categories of circumstances can help a manager predict accurately what actions will and will not lead to the desired result, given the circumstance in which he or she finds himself/herself (Carlile and Christensen, 2005).

visit to the case study sites for briefing sessions, as well as before starting the individual interviews, informants' consent to participate in the research was explicitly obtained (Mason, 2002). Also, before beginning the individual interviews, the consent of the informants to record the conversation was obtained and assurance made to them that the contents of the individual conversations to would not be revealed to anyone (Robson, 2002).

5.10 RESEARCH PROCESS

Empirical research is essentially a cyclic process, which starts with questions about the real world, progresses through the stages of data collection, analysis and interpretation to eventually arrive at some conclusions about the real world. "While the series of steps involved in the research process are "locally directional," the process itself is "systematically circular" in that it begins with a problem and gets back to the problem, although not with the same starting point" (McGrath, 1982). This section describes the research process – the sequence of steps that this research progressed through from its beginning till end. As Figure 5.2 depicts, the research progressed through various stages involving theoretical and empirical research activities. The research formally began in April 2004 and the empirical investigation phase (site visits and data collection) was conducted during June 2005 and January 2007. Three factors motivated this research: (1) the opportunity to make an early scholarly contribution to the understanding of a relatively recent phenomenon (2) the growing importance and propensity of offshoring of R&D, and (3) my own curiosity to understand certain strategic dimensions associated with offshoring of R&D.

The first step in the process involved defining the research agenda, clarifying the research objectives and formulating the specific research questions that this study sought to address. In order to accomplish this, a preliminary review of the published literature was conducted and several surveys and articles published in the business press were perused. Numerous conversations with a number of senior managers from the industry were held to obtain their perspectives. This stage of the process was also influenced by my own many years of managerial experiences, background, and interests. In addition, a survey was also administered to a population of 65 leading managers and scholars located in different parts of the world to ensure the validity and relevance of the research questions. Following this, an in-depth review of the scholarly literature on R&D globalization was performed. In addition to academic journals, articles in business press and resources available electronically from the World Wide Web were perused. Although literature review was an ongoing process throughout the course of this research, this phase helped fine-tune the research questions and the anticipated contributions to theory and practice.

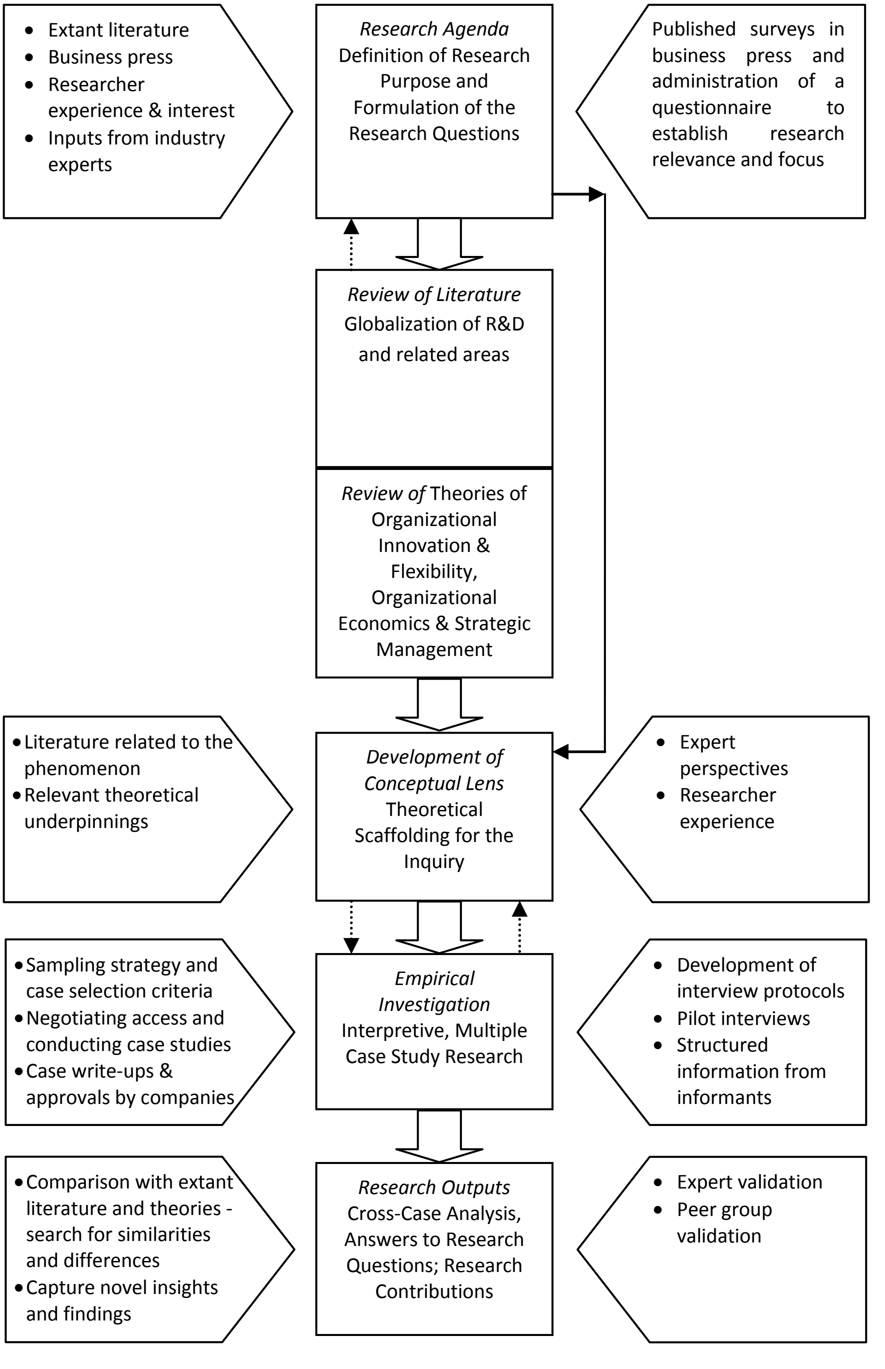


Figure 5.2: Research Process

The literature review phase revealed that despite its growing importance the scholarly literature on offshoring of R&D was yet to develop. Moreover, it was also evident that while much has been published on the various aspects related to organization and management of R&D globalization, the literature dealing with innovative capability and organizational flexibility was still scarce. This led to a rigorous review of the theories of organizational innovation, literature on organizational flexibility, and the various strategic management and organizational economics theories that could provide conceptual support for research. Drawing from the two-step literature review phase, the next step in the research process involved developing a conceptual lens to shed light on the phenomenon and its focal aspects. In addition to insights and concepts derived from the literature, experiential perspectives obtained through conversations with industry experts were integrated to develop the conceptual lens to obtain guidance for the empirical inquiry that followed.

The actual empirical investigation was preceded by a preparatory phase that involved (a) development of protocols (including interview guides) for field data collection, which was driven both by the research questions and the conceptual lens, (b) identification of the potential case study sites and securing access, and (c) conduct of pilot interviews to gain experience with data collection and to refine the interview guides as well as the conceptual lens. The actual empirical research phase consisted of carrying out multiple, in-depth case studies, data gathering and data analyses, including the cross-case analysis (Yin, 2003b). Because of the inductive nature of the study (Eisenhardt, 1989b), the conceptual lens was progressively refined as the research moved from one case to another. The research culminated in delivering the intended research outputs – answers to the research questions and a normative theory addressing the focal aspects of the phenomenon of offshore R&D. Close and frequent interactions with the case study sites were an integral part of the research process not only for seeking their perspectives as emergent insights developed, but also for obtaining feedback and clearances for the case study reports.

5.11 SUMMARY

The goal of the empirical research was to gain a first-hand understanding of the phenomenon of offshore R&D and to develop theory that can explain the link between offshoring of R&D and firm innovative capability and organizational flexibility. Due to absence of any prior work on the focal aspects of the phenomenon, and limited support available from the extant literature, an interpretive, multiple case study approach was used for the empirical inquiry. This approach allowed for inductive development of understanding and explanation in a grounds-up manner rooted in empirical reality. Since the research approach allowed direct access to actors enacting the phenomenon, rich, multifaceted perspectives ensued. Also, multiple case studies provided exposure to a wide variety of contexts, structures and organizational processes through instances of the phenomenon. The research paid particular attention to the effectiveness of its design and issues pertaining to quality and validity. Thus, the research approach facilitated the accomplishment of the three research purposes that motivated this study. The empirical research generated a rich understanding of the phenomenon and its focal aspects, and facilitated the development of a normative theory. Since a systematic connection to 'practice' was central to the research approach employed, it also generated rich insights for practice.

CHAPTER 6
CASE STUDIES

THE PRECEDING CHAPTER described the methodology used for carrying out the empirical research. Among other things, Chapter 5 addressed the multiple case study design along with the criteria for case study site selection and informant selection as well as data collection and analysis methods. This chapter presents the actual case studies that provided data for the empirical inquiry. A total of 8 in-depth case studies formed the empirical base for this research. All cases pertained to offshoring of software R&D. However, as mentioned in Chapter 5, the multiple case study design in this research sought maximum variation across cases. Accordingly, the case studies covered a range of industries and included both intra-firm offshoring of R&D (captive offshore R&D) and inter-firm offshoring of R&D (offshore R&D outsourcing). Table 6.1 provides details of the case studies conducted.

Table 6.1: Overview of Case Studies

Serial #	Type of Offshore R&D	Industry
Case 1	Intra-firm	Enterprise Software
Case 2	Intra-firm	Enterprise Software
Case 3	Intra-firm	Medical Systems
Case 4	Intra-firm	Enterprise Software
Case 5	Intra-firm	Consumer Electronics
Case 6	Inter-firm	Semiconductors
Case 7	Inter-firm	Media and Entertainment
Case 8	Inter-firm	Security and Surveillance

The case studies provide raw data for the comparative, cross-case analysis. The case study reports use a common template based on the dimensions of inquiry discussed in Chapter 5. However, the level of details across cases vary somewhat. This is due to the fact that five out of the eight participating case study companies requested anonymity. As a result, not only their names have been disguised but any information that could potentially reveal their identity has been excluded. Also, because of the business and organizational sensitivities involved in offshoring of R&D, the degree of details obtained varied considerably across case study sites. In this chapter, each case is presented as-is with occasional interpretation interwoven along with description. The case study reports quote informants extensively in order to present the contextual aspects of the offshore R&D engagements as fully and richly as possible. Each case study report concludes with a section that captures the major impressions from the case.

6.1 CASE STUDY I: VERITAS SOFTWARE CORPORATION

VERITAS Software Corporation is one of the leading software product companies in the world having operations globally. In 1992, the company first experimented with offshoring of its R&D to India and eventually set-up its own R&D center in Pune in 1994. Currently, the India R&D Center employs about 900 people and is the largest R&D base for VERITAS outside of the United States. Interestingly, while the company's R&D centers in the U.S. and elsewhere typically focus on single product line, the VERITAS India R&D Center carries out R&D and product development work cutting across several of the company's product lines. This section presents a case study on the offshore R&D engagement between VERITAS India and VERITAS Software Corporation, U.S.A. The case study encompassed an in-depth examination of the major R&D programs at VERITAS India R&D Center to understand how it supports VERITAS Software Corporation's competitive needs for innovative capability and organizational flexibility.

Initially, in April 2005, I visited the VERITAS India R&D Center in Pune to gain a preliminary understanding of the activities going on there. During the visit, I also gave a presentation on the scope, aims and objectives of my research to more than 25 senior managers and technical leaders. Following this, in consultation with the VERITAS India R&D General Manager, and based on a few documents provided by him, I identified a set of informants whom I wanted to interview for the cases study. Identification of the informants was done with a view to be able to interview the key managerial and technical people across major programs in the offshore R&D engagement, and was based on the informant selection criteria described in the research methodology chapter. This included people from the various R&D programs at VERITAS R&D Center in Pune, India and their main counterparts in the U.S. Informants at VERITAS R&D Centers in the U.S. were interviewed by telephone. All other interviews were done face-to-face, one-on-one at VERITAS R&D Center in Pune. The interviews took place during July – September 2005.

Table 6.2 provides details of the interviews conducted for the case study.

Table 6.2: Details of the Interviews Conducted at VERITAS

#	Position/Role	Location	Date of Interview	Mode of Interview
1	Manager – Q. A., Cluster Server Product	Pune, India	July 27, 2005	Face-to-Face
2	Senior Director, Data Management Group	Pune, India	July 27, 2005	Face-to-Face
3	Senior Manager, User Centered Design Group	Pune, India	July 27, 2005	Face-to-Face
4	Vice President, Cluster Server Product	Mountain View, USA	July 28, 2005	Telephone
5	Vice President, Storage Foundation Products	Mountain View, USA	July 28, 2005	Telephone
6	Engineering Manager, Cluster Server Group	Pune, India	July 28, 2005	Face-to-Face
7	Engineering Manager, File Systems Group	Pune, India	July 28, 2005	Face-to-Face
8	Director, Data Management Group	Pune, India	July 28, 2005	Face-to-Face
9	Director, Storage Foundation Group	Pune, India	July 28, 2005	Face-to-Face
10	Technical Director, New Initiatives	Pune, India	July 28, 2005	Face-to-Face
11	Senior Staff Executive, Global R&D Strategy	Pune, India	July 28, 2005	Face-to-Face
12	Director, Server and Storage Group	Pune, India	July 29, 2005	Face-to-Face
13	Director, Data Management Group	Pune, India	July 29, 2005	Face-to-Face
14	Principal Engineer, Volume Manager Group	Pune, India	July 29, 2005	Face-to-Face
15	Engineering Manager, Volume Manager Group	Pune, India	July 29, 2005	Face-to-Face
16	Engineering Manager, Volume Manager Group	Pune, India	July 29, 2005	Face-to-Face
17	Manager, Certification Lab	Pune, India	July 29, 2005	Face-to-Face
18	Senior Director, Shared Infrastructure & Security Development Group	Mountain View, USA	July 29, 2005	Telephone
19	Vice President, Cluster Server Product	Mountain View, USA	August 4, 2005	Telephone
20	General Manager India R&D	Pune, India	August 29, 2005	Face-to-Face

6.1.1 Background and Context[1]

VERITAS Software Corporation, founded in 1982 and headquartered in Mountain View, California, is a leading independent supplier of storage and infrastructure software products and services. With revenue of US $2.04 billion in 2004, VERITAS ranks among the top 10 software companies in the world and, as of December 31, 2004, had 7,587 employees in 38 countries2. VERITAS delivers products and services for data protection, storage & server management, high availability, and application performance management. VERITAS products are used by 99 percent of the Fortune 500 companies as well as a variety of small and medium-sized enterprises located around the world operating in a wide variety of industries. The company has historically grown organically and through acquisitions. In the fiscal 2004 alone, VERITAS acquired three companies[3].

VERITAS software products operate across a variety of computing environments, from personal computers and workgroup servers to enterprise servers and networking platforms. These products are used in corporate data centers to protect, archive and recover business-critical data, provide high levels of application availability, enhance and tune system and application performance to define and meet service levels and enable recovery from disasters. Its solutions enable businesses to reduce costs by efficiently and effectively managing their information technology infrastructure as they seek to maximize value from their IT investments. VERITAS software products can be broadly categorized into three categories:

- Data Protection: products for ensuring the protection, retention and recovery of data using disk, tape and optical media. Key products in this category are: VERITAS NetBackup, VERITAS Backup Exec for Windows, and VERITAS Enterprise Vault.
- Storage Management: products for optimizing storage hardware utilization, simplifying administration for environments with diverse computer hardware and software architectures and enabling high performance and continuous availability of mission-critical applications. Key products in this category are: VERITAS

[1] Source for all the information about VERITAS, its business and products is the company's fiscal 2004 annual report filed with SEC in USA. Wherever appropriate, such information have been reproduced from the annual report as-is so as to avoid any loss or compromise of the information.

[2] On December 16, 2004, VERITAS Software Corporation and Symantec Corporation announced that they had entered into a definitive agreement to merge in an all-stock transaction. Effective July 2, 2005, the intended merger was completed. I interviewed people at VERITAS during July – September 2005. Even though the merger had already been completed, the changes due to it had not come into effect. Moreover, the product lines of VERITAS and Symantec were complementary to each other, which meant that a large part of VERITAS product R&D would continue as before. Therefore, my plan of doing an in-depth case study at VERITAS was not impacted in any way despite the merger.

[3] Ejasent, Inc. (January 2004), Invio Software, Inc. (July 2004), and KVault Software Limited (September 2004)

Storage Foundation, VERITAS Replication Exec and Volume Replicator, and VERITAS Storage Exec.
- Utility Computing Infrastructure: products for automating the provisioning and management of servers and applications to meet IT service levels for high availability, high performance and process automation. Key products in this category include VERITAS Cluster Server, VERITAS Command Central Availability and Command Central Service.

In addition to its numerous product offerings, VERITAS provides a full range of services to assist its customers in assessing, architecting, implementing, supporting and maintaining their storage and infrastructure software solutions. Its global services organization provides customers with maintenance and technical support, consulting and education services. A high level of customer service and technical support is critical to customer satisfaction and VERITAS' success in increasing the adoption rate of its solutions. VERITAS offers seven-day a week, 24-hour a day telephone support as well as e-mail customer support.

6.1.1.1 Business Environment, Success Factors and Strategy at VERITAS[4]

Demand for VERITAS software products and services is driven by the ever increasing quantity of data being collected and the need for data to be protected, recoverable and accessible at all times, particularly in the event of a disaster. Other factors driving demand include the rapid increase in the number of Internet users and companies conducting business online, the continuous automation of business processes, increased pressures on companies to lower storage and server management costs, while increasing the utilization and performance of their existing heterogeneous IT infrastructure and the increasing importance of document retention and regulatory compliance solutions.

The principal markets in which VERITAS competes are data protection, file system and volume management, clustering, replication, storage resource management, storage area network management, automated server provisioning, application performance management and centralized service level management. These markets are intensely competitive and rapidly changing. The principal competitive factors in the industry structure in which VERITAS operates include product functionality, product integration, platform coverage, price, ability to scale, worldwide sales and marketing infrastructure and global technical support. Therefore, VERITAS' market competitiveness and growth depends on its ability to develop superior products more rapidly and less expensively than its competitors, to educate potential customers as to

[4] This section has largely been adopted from VERITAS Software Corporation's 2004 Annual Report.

the benefits of licensing VERITAS products rather than relying on alternative products and technologies and to develop additional channels to market.

Many of VERITAS' strategic partners including EMC Corporation, Hewlett-Packard, IBM, Microsoft, Oracle and Sun Microsystems either offer software products that compete with its products or have announced their intention to focus on developing or acquiring their own storage and enterprise management software products. So, VERITAS competes with these companies for a share of the market. Interestingly, some of these companies also resell VERITAS products and in some cases incorporate its technology into their products or solutions. VERITAS also competes with hardware and software vendors that offer data protection products, file system and volume management products, clustering and replication products, storage area networking management solutions, automated server provisioning solutions and centralized service level management products. It competes with software vendors that offer application performance management solutions and systems management companies that are integrating storage resource management functions into their platforms. Some of the VERITAS products also compete with enterprise management vendors, including BMC Software, Computer Associates, Mercury Interactive Corporation, and Quest Software.

VERITAS product strategy is aimed at meeting the data storage, system and application availability and performance needs of its customers, while remaining at the forefront of innovation to support its customers' long-term requirements by providing the building blocks for utility computing. Utility computing is a computing model that delivers IT as a measurable service, aligned with business needs and capable of adapting to changing demands. VERITAS offer a building block approach that allows its customers to evolve to a utility computing model in an evolutionary and modular fashion while leveraging their existing IT investments. VERITAS' business strategy is to continue to compete in its current markets while expanding and integrating its product portfolio in the area of utility computing infrastructure, to continue to expand its product offerings across key operating system platforms including Linux, NetWare, UNIX and Windows, and to continue to invest for growth in international markets. VERITAS considers continued expansion of its international operations as a key component of its growth strategy, especially in emerging markets in the Asia Pacific region.

6.1.1.2 Research and Development at VERITAS

Being at the forefront of data protection and storage technology, VERITAS invests significant proportion of its revenue on research and development activities. In the fiscal year 2004, the company spent US $346.6 million on research and development, which accounted for 17% of its net revenue. The Figure 6.1 shows net annual revenues and R&D spends at VERITAS over the last three fiscal years. For VERITAS, technical leadership is essential to its success and therefore it is committed to investing substantial resources to research and development. It has research and development centers in India, the United Kingdom, Israel, China and Japan in addition to three centers in the United States (Mountain View, Heathrow and Roseville). Of its total 7,587 employees, 2,312 people work in research and development.

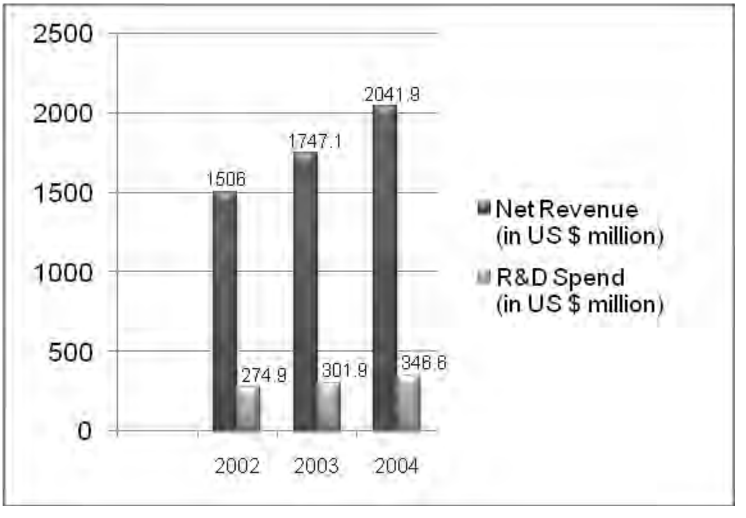


Figure 6.1: VERITAS Net Revenue and R&D Spend During Fiscal 2002 - 2004

Research and development efforts at VERITAS have been directed toward developing new products for the computer operating system platforms like Linux, NetWare, UNIX and Windows, developing new features and functionality for existing products, integrating products across its existing product lines, porting new and existing products to different operating systems and expanding its product portfolio into new markets such as e-mail archiving, application performance management, server provisioning and centralized service level management. At the time of this case study, VERITAS's research and development thrust areas included:

- Operating system platform expansion: porting of the majority of the company's traditional storage software and enterprise data protection products to Linux, NetWare, UNIX and Windows.

- New utility computing infrastructure products, including server provisioning, clustering, application performance management and service level management.
- Replication, storage resource management and next generation virtualization technology.
- New data protection technologies for disk-based data protection, regulatory compliance and disaster recovery.

VERITAS' future success depends on its ability to enhance existing products, respond to changing customer requirements and develop and introduce new products in a timely manner that keep pace with technological developments and emerging industry standards. As is evident from the amount of its annual R&D spend, the company continues to make substantial investments in developing new products, which may or may not be successful. It also faces the risk of not being able to complete its research and development programs successfully, which may affect the timely availability of its future products or achieve market acceptance. A U.S. based senior Vice President captured the challenges faced by VERITAS R&D to ensure company's competitiveness in the marketplace:

> *We need to make the best in class products available in the market on multiple platforms. The capabilities our products offer are also embedded in native operating systems like Unix, Windows and Linux, which means our products have to be far superior to those and they must work across a range of platforms. Many of our customers are quite conservative, so cycle time is really not all that critical. However, when, for example, Microsoft releases a beta of their new Windows operating system, our products have to be available for our customers to test. So, we need to keep pace with the operating system vendors. Supporting the product on new operating system releases and taking advantage of new developments is one aspect but there is pressure to add or release new features and functionality, and for this time is critical.*

6.1.2 Offshoring of R&D by VERITAS

VERITAS first experimented with offshore R&D back in 1992. Being an entrepreneurial company with its own R&D capacity constraints, VERITAS needed its products ported on various operating system platforms. The Chief Technology Officer and Executive Vice President for Advanced Technology, Fred van den Bosch explored locations like Singapore to expand the company's R&D capacity before settling on India. With the assistance of an intermediary, Fred decided to award some R&D work to a Pune-based company called Frontier Technologies. This work involved porting of two VERITAS products – VERITAS File System and VERITAS Volume Manager –

onto Sun Microsystems' Solaris/Sparc platform. The interviews reveal that at that point in time VERITAS wanted to experiment with expansion of R&D capacity in a very cost effective way. In fact, it is widely believed within VERITAS that the company did not use much of its own money for this project; instead, it capitalized on USAID funding for doing the project in India. However, several informants believed that Fred's choice to expand R&D in India was based on his impressions of the Indian population in the Silicon Valley that has been hugely successful and had a reputation for technical prowess. Fred, it seems, conjectured that tapping the Indian technical talent pool in India would not only allows access to bright people in large scale but also at low cost.

Informants believe that Frontier Technologies was awarded the project for no special reason. Frontier really did not have much of UNIX expertise. It seems that Fred was convinced with the commitment and abilities of Frontier Technologies to deliver on the project objectives. The pilot project that was given to Frontier Technologies was completed by the end 1993. Inspired by the success of this experiment and the growing need to expand R&D capacity, in early 1994 VERITAS India R&D Center was established in Pune. Frontier transitioned all the work it had done up until then along with the 4 people that had staffed the project to the newly set-up VERITAS India R&D Center. The products developed at Frontier were indeed strategic for VERITAS but were not on the short-term product/market path for the company. As a matter of fact, this work – the first port of Solaris - came out as a product only in early 1995. However, it proved to be a huge success for VERITAS. As it turns out, the File System and Volume Manager products on the Solaris/Sparc platform provided maximum revenues for VERITAS for the next decade or so. In 1999, VERITAS Software Corporation acquired Frontier Technologies in an all-cash deal.

Since the time of its establishment in 1994, the VERITAS India R&D Center has grown to nearly 900 people to become the largest R&D base for the company outside of the United States. The interviews indicate that low-cost, high quality technical talent pool continues to be the major driver for growth of R&D in India. The abundance of talent pool makes it easy to quickly ramp-up the needed staff on new projects when compared to the U.S. or other locations.

The scope and complexity of work at VERITAS India R&D centre has gradually evolved. Due to a growing acknowledgement of its technical capability as well as for reasons of low cost talent reservoir, the India R&D Center now has a substantial R&D footprint, performing work for almost all major product lines of the company. However, the extent of responsibilities varies across product R&D groups. In many cases, the India Center has full responsibility for some of the products, including its release to market. For example, VERITAS Cluster Server (VCS) product, which is the number one product in its category in the market with annual revenue of U.S. $150 million in 2004, has 80 of its 160 people strong R&D group in India. The VCS R&D group in India has responsibilities across a range of platforms and is also deeply engaged in developing the future product offerings for VERITAS. Likewise, the Storage Foundation Group, which includes the flagship Volume Manager product, has 50% of its total R&D resources (375 people) located in India.

Data Management Group, which accounts for nearly 50% of VERITAS revenue, has substantial R&D presence in India. For example, two of its leading products, NetBackup and Backup Exec, with revenues of U.S. $500 million and U.S. $400 million, respectively, are being co-developed by teams in India and the U.S. Storage Exec – a sub-product of VERITAS Backup Exec, is now fully owned by the India R&D Center. In addition, the India center is working on new initiatives to develop the client side software for Backup Exec as well as security testing of the data management products. The India R&D organization has also been entrusted with parts of a new VERITAS wide initiative to develop the next generation data management product called Integrated Data Management.

The data management R&D group in India has grown from 50 people in 2004 to 200 people in 2005. A significant part of the data management R&D work is currently in transition from Roseville and Heathrow (both in the U.S.) to Pune as a result of a recent corporate decision to establish the India R&D Center as the center for excellence for presentation and management layers of the data management products[5]. However, what is interesting is that the NetBackup product has existed for more than ten years now and India's involvement with the product started only with the release 4.0 (right now NetBackup is in release 6.0). So, the India R&D center got involved with the product at a time when it was already quite mature.

On the other hand, it is also to be recognized that certain technologies like tape based storage, which the NetBackup product has traditionally relied on, are maturing and giving way to new disk based storage. In view of these changes, the aspects related to product usability and manageability assumes importance. The India R&D team is responsible for these two aspects of the product. Additionally, the transition from tape-based storage technology to the disk-based storage technology suggests that moving forward the India R&D team will be responsible for architecting future versions of leading products such as NetBackup.

The other VERITAS product groups such as Storage Foundation and Server and Storage Management also have substantial R&D presence in India. For example, currently the India R&D Center is responsible for supporting VERITAS File Systems

[5] These layers refer to the upper two layers of a four-layer data management product stack.

(VFS) product on all operating system platforms, including features, releases, etc. Initially, this group was responsible only for developing VFS on HP-UX platform and managing OEM relationship with Hewlett Packard. Similarly, the Storage Foundation Group in India is responsible for developing the Volume Manager product on Linux and Sun Solaris operating systems. The Windows based Server and Storage Management Group, which includes Clustering, Volume Manager and Replication products, has almost 65% of its R&D resources in India. Except for the Volume Manager product, for which the center of gravity is in Mountain View, the India center has most of the responsibilities for Clustering and Replication products as well as for Windows solutions. Towards that, the India R&D center has the ownership of product roadmaps, release roadmaps, and the technology roadmaps.

The India R&D center also houses parts of horizontal R&D groups such as the Shared Infrastructure and Security Development Group, which develops common components for authentication, authorization, reporting, scheduling, etc. that are used across VERITAS products. In addition, one of the five C-Labs, which certify VERITAS products on various platforms, is located in India. India also houses one of the two Performance Labs (the other one being in Mountain View) that are focused on addressing product performance requirements. The R&D center in India has a unique UCD Lab (User Centered Design Lab), which was initiated by the India organization and now has a widespread acceptance within all of VERITAS. So much so, that a small UCD Lab was also started in Mountain View. The UCD Lab in India, which has 20 people, strives to represent the end customer usability aspects during the design of the product.

However, the India R&D Center is not a full-fledged R&D Center. It does not have its own product-market mandate as well as R&D budget. Instead, it is an R&D outpost for the product units headquartered in the U.S. and works as their extended R&D teams. Yet, the signs of progress towards becoming an R&D center at par with other more established VERITAS R&D centers seem to be very encouraging. For example, consider the VERITAS operating model, in which typically people at the Vice President level manage product portfolios in the range of U.S. $100 million plus, whereas the Directors handle products that have revenues in the range of U.S. $10-25 million each. The senior managers in India are all at the Director or above levels, which gives the India Center a tremendous influence.

The U.S. and European markets continue to be the primary revenue sources for the company. However, lately, the emerging market opportunities in India and the larger Asia-Pacific regions have also emerged as a motivation for the new thrust on growing R&D capability in India. This thrust is in its embryonic stage and an emerging market strategy with India as the crucible for new growth has yet to be panned out for

VERITAS. Recently, the India R&D Center embarked on new initiatives to address emerging market opportunities such as developing an integrated solution for disaster recovery operations management. A dedicated R&D team in India crafted a vision and developed a concept for validation by VERITAS product groups. This initiative is now sponsored by the VERITAS Cluster Server Product Group, which is now facilitating productization of the solution.

Figure 6.2 shows the organization structure of the VERITAS R&D Center along with its span of responsibilities. As the organizational structure suggests, the India R&D Center employs an integrated organizational structure, which means that all R&D groups based in India have a common reporting into the India R&D General Manager.

6.1.3 Organization and Management of Offshore R&D in VERITAS

This section presents an account of the organizational and management processes associated with VERITAS' offshore R&D engagement. The section begins with a discussion of the structural characteristics of the offshore R&D engagement between VERITAS U.S.A. and VERITAS India R&D. Then, an account of the relational characteristics is presented. Finally, a description of the R&D task allocation practices as seen in the VERITAS offshore R&D engagement is provided.

6.1.3.1 Structural Characteristics

Despite growing to a size of 900 R&D resources to become the largest VERITAS R&D center, the India R&D organization is still largely operating as an extended R&D group. This is evident from the fact that all R&D groups in India are funded by their respective product units, even though the India R&D center has an integrated management structure. All R&D directors in India report into the India General Manager but have a dotted line reporting into their respective product group vice presidents back in the U.S. So, in practical terms, each R&D group in India works as an extended team even though an overlay organization structure for the India center exists. So, at this juncture, the India R&D Center is not a full-fledged R&D organization, as it does not have its own budget and an independent product-market mandate.

What is noteworthy is that product and program management teams for all the VERITAS products are located in the U.S. and the R&D teams in India have to coordinate with these organizations. Likewise, most part of the sales, pre-sales and marketing functions are based in the U.S. What this concentration of customer facing teams in the U.S. means is that the India R&D teams do not have access to the customers and instead must work through the U.S. based teams. Customer and market requirements are funneled to the India R&D teams from their U.S. counterparts and product management organizations. All R&D and product decisions

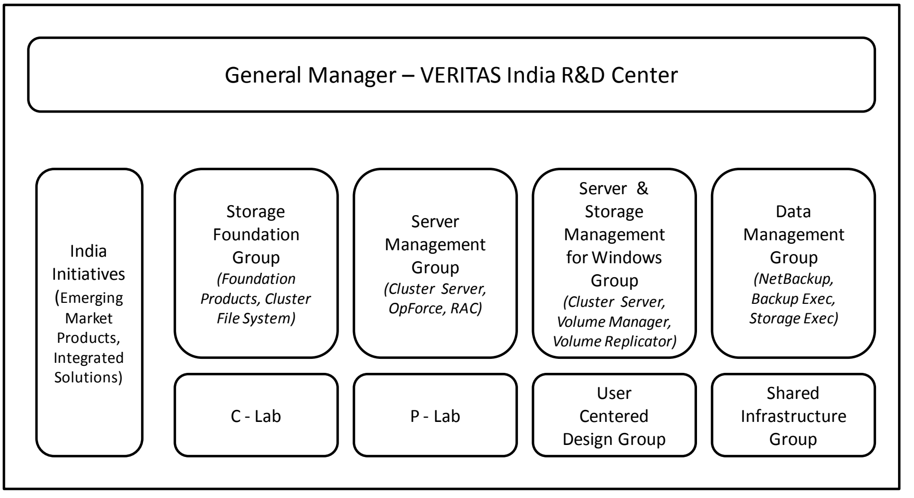


Figure 6.2: VERITAS India R&D Organization Structure

are made by the product unit heads based in the U.S. They also decide the work programs that are to be executed in India and allocate budgets accordingly. As a matter of fact, the people who are accountable for the products and their marketplace performance are all in the U.S. Figure 6.2 shows the organization structure of VERITAS India R&D Center, whereas the governance structure for the relationship dyad is depicted in Figure 6.3.

In the wake of the plans to establish the India R&D Center as a crucible for growth for VERITAS by leveraging emerging market opportunities, the governance structure is likely to change soon. In its new role, the India Center will have full autonomy and a distinct product-market mandate. Currently, however, the governance structure has some inherent problems, which stem from a lack of clarity and alignment among the stakeholders on the charter for India R&D. The perspectives obtained from the informants suggest that the charter as described by the senior most executives at the company headquarters is probably different from what is seen at the operating (middle management) level. The charter at the senior most level is to be able to expand the R&D capacity for VERITAS and leverage technical innovations from India. However, at the middle management level, which is the operating level, the charter takes a much more tactical form. The interviews suggest that this is largely due to fear of loss of control as well as jobs among the people in the U.S., which results in not taking a long term view of what can be done to strategically leverage the India R&D Center. Instead, the approach becomes much more tactical to consider how India can be used to support a particular product release. According to the General Manager for the India R&D:

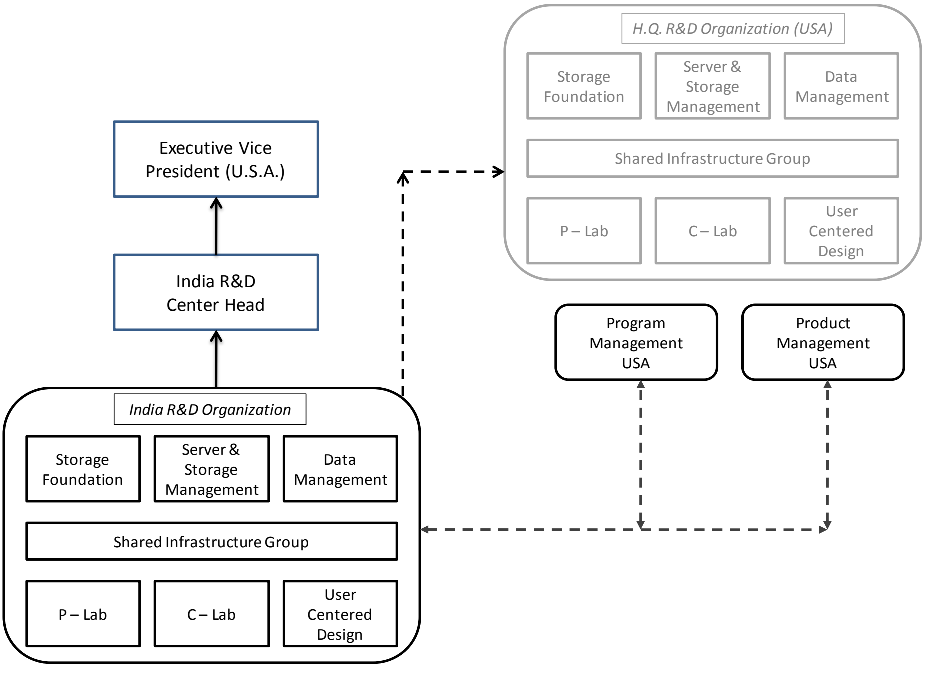


Figure 6.3: Organization and Governance of Offshore R&D at VERITAS

> *I think at senior level it is viewed as more of a capability that needs to be leveraged but at a tactical level, it is viewed as a resource pool that needs to be leveraged to get a release done. At the operating level, it becomes more of a release focus rather than a capability building kind of a focus.*

6.1.3.2 Relational Characteristics

There is a wide variety in the dyadic relationship and this seems to have gone through many ups and downs, as the following remark of a senior staff executive based in Pune suggests:

> *Even though the relationship in the early stages was good, somewhere it took a different turn. Reasons for this are many and include the attitude of the operating level leadership, inclusivity of remote teams, threat of jobs, lack of confidence and trust, insufficient flow of information, micromanagement, etc. In fact, when I joined, I*

> *received a welcome email from a US based director, which said, "Your quality stinks." Right now, there is a tendency to withhold knowledge because there is a feeling of what if I become redundant.*

A peer-to-peer structure does not exist, which is largely because of the organizational heritage, as attested by the Vice President of the VERITAS Cluster Server Product based in the U.S.:

> *Currently, we do strategy and the budget, so it is not a perfect peer to peer structure. I guess it is the Headquarters effect. The division head as well as sales and marketing are all here.*

Existence of a mother-daughter relationship, or in more formal terms, a principal – agency structure is clearly visible. In most cases, the agency structure is a tighter one indicating a preference for control and conformance and giving a sense of capability difference and inequality. Consider the following remarks, for example, which suggest varying degrees of relationship structures as seen from a management control point of view.

> *There is tendency for the Pune team to try and take on too much. This may be a natural thing because they want to prove themselves but there are real capacity and experience issues. – Senior Vice President, VERITAS Cluster Server Product, USA.*

> *I have seen in some cases the leadership in Pune has chosen an independent direction and that affects trust and project success; efforts get fragmented. There is desire for more independence than what is proved. – Senior Director, Shared Infrastructure & Security Development, USA.*

> *We face "Are you good enough?" phenomenon, which leads to micromanagement. I don't own the product, and there is tight management. – Senior Director, Data Management Group, India*

However, irrespective of the nature or state of the relationship, many at the VERITAS offshore R&D team in India realize that quality of the relationship could only improve gradually with trust, which would happen over a period of time with demonstrated capabilities. The central role of trust in the gradual evolution of an offshore R&D relationship is best illustrated by the following remarks of a Pune-based Principal Engineer associated with VERITAS Volume Replicator product.

> *In my experience, you are not going to be given something because you are asking for it. The way it works is that you have to prove*

> *yourself and convince people about your capabilities, initially by doing smaller things. People in the U.S. obviously have more experience and we needed to learn from them. In the US, there were people who were always willing to help and there were also those who would be terse about us. But the attitude we took was, okay, those people know more about things and so we will do whatever we can to learn from them. We started with a porting project to HP-UX and subsequently, we owned future HP releases. Later, we started prototyping features, minor perhaps. But in 2002 timeframe, we proposed two major features. The people in the U.S. did not care, because they thought we won't be able to do them as they were quite complex ones. That was a defining period for us. Management was quite supportive and eventually we scaled up to higher responsibilities with greater impact.*

When the VERITAS Cluster Server R&D group in India started working on core components, it started by doing enhancement work. That was an essential aspect of demonstrating capabilities and gaining trust. Over the last 5 years, the team's responsibilities have substantially increased, supported by the willingness of U.S. team to let them do more and more work based on expertise they have. For the next generation clustering product, the Indian team was involved from the day one. They would closely interact with Mountain View team members to plan the product features and scope out the work responsibilities. That happened very naturally. The two teams ensured that the overall product design and the associated responsibilities were clear. By design, each team was to work on a few components and too much interaction between the teams was not desired except for weekly synch-up calls. Allocation of the work was based on competencies on each side. In this product development work, a lot of new knowledge was involved such as understanding new trends in operating systems and taking advantages of those. The weekly synch-up calls served as platform for the crucial knowledge exchange.

An Engineering Manager associated with the VCS product R&D in Pune summarized her experience with the progression of the relationship thus:

> *We are removed from customers and markets, and that is reality. We had to prove ourselves by doing small things, we had to gain trust, and we had to convince them on our capabilities. Now, it is a good, peer-to-peer relationship. It's more like collaboration and there is a lot of interaction. We demonstrated by action, which resulted in trust in our capabilities.*

The interview findings suggest that this is how most product groups started, by doing smaller, simpler things initially and later as their capabilities were proven, they received higher levels of R&D responsibilities. For example, the Storage Foundation Group displays a similar story concerning the evolution of its relationship with the U.S. counterparts. Over the last 6-8 years period, the India R&D team acquired substantial experience and now they work independently with occasional hints from across the oceans. Over a period of time, the balance of power has shifted, confidence got built, and the managers in the US realized that India was pulling hand in hand with the US teams. So, gradually platform based product ownership came to the Storage Foundation Product Group in India.

Most managers at the India organization hold the common view that trust is the most critical factor in an offshore R&D relationship and that there is no formula for trust; it takes time. However, there is also a realization that irrespective of the nature and quality of the relationship, certain things will never change in the offshore R&D model due to organizational heritage. The Director of the Windows-based Server and Storage Management Group at the India R&D Center made a very poignant observation:

> *The relationship structure is that of H.Q. to Satellite. Mountain View is the center of the universe. A good healthy relationship is crucial for impact. But no matter what, product roadmaps are controlled by the U.S. For that to change there has to be shift in market demographics.*

There is another side to the growth in the relationship, especially if deeper relationship means increasingly responsibilities. The gradual transfer of power brings in friction, which becomes an inherent part of the relationship. Even if there is a senior management level buy-in, the operating challenges at the middle management level often surface as friction as seen in the various offshore R&D programs in VERITAS. So, people at the VERITAS R&D India organization believe that it is important to have the right people representing them. Most groups also try to follow agreement based management to minimize the friction but sometimes they have to involve the executives who proposed a particular path.

The relationship between the constituents of the dyad seems to be a complex one. It is not a straightforward relationship. There is a wide variety in the relationship and it seems to be always changing. A certain political dynamic seems to be at play in the relationship, which is characterized by a good degree of stress and strain. Stress seems to be emanating from the lack of authority (lack of budget), accountability and ownership. However, there are signs that the source of the stress have changed. For example, one of the Directors that I spoke to at the India R&D Center said:

> *Earlier we could not hire a candidate without approval from the U.S., but now we have the authority to hire on our own.*

The position of the senior leadership of VERITAS seems to suggest that leveraging India as an engine for growth for the company is a priority. The emerging markets in Asia Pacific offer significant opportunities for market expansion and this is something that is well recognized within the company, but the pace of change is rather slow.

The VERITAS India R&D General Manager has a vision to leverage the India center as a crucible for growth for the company, and he is steering the Center into a state of more autonomy and a well-defined market focus. The India R&D organization is currently a cost center but is striving to become a profit center with its own product market mandate pursuing emerging market opportunities. The senior management of VERITAS is in alignment with this vision for the India organization. Ever since he assumed his position in 2004, the General Manager for the India R&D Center initiated several measures to establish the India center as a more strategic innovation base for VERITAS. His main aim has been to influence a change to ensure a deliberate strategy for the India R&D Center. This included strategic work allocation for competency and ownership building and securing a product-market mandate for the India R&D center aligned to the emerging markets so as to be able to generate a deeper impact on business performance. Towards that, a key step has been to install an integrated management structure at VERITAS India, so now all the R&D directors have common rep with dotted line reporting to their product unit vice presidents in the U.S. This is a radical departure from the past where R&D directors reported to their product unit heads or someone else in the U.S. This change has caused tension in the relationship.

What is the significance of the new integrated management structure, when all the company really needs is product unit goals being met? The General Manager for the India R&D Center observed:

> *If you separate the two missions – remote development centre, which makes a bottom line impact versus the emerging markets mission, which is about top line impact, we need integrated management for driving the change aligned with the new mission. New markets served, 5% revenues generated from India, and the like. This is really sprinkling versus new venture approach for new trajectory of the organization.*

Besides product unit related R&D goals, the India R&D center now also has a set of ‘India’ goals. Clearly, two sets of what might be seemingly opposite sets of goals is a cause of additional tension in the relationship dyad. This is especially so since there is a prevailing perception that there is a mismatch between aspirations and organizational readiness as far as the India R&D center is concerned. On one hand, there is a shifting end-to-end responsibility for products but also there is diffidence about the capability set of the organization's ability to make decisions. In view of the Vice President for the VERITAS Storage Foundation Products, based in the U.S.:

> *We don't have seasoned managers in India. I think with very little experience they got there. So, the responsibility is great but the status is not there.*

The India R&D General Manager is in concurrence with the prevailing view about the inadequacy of well-rounded experience and decision-making capabilities within the India organization.

> *We don't have a proven capability on the front end part of the product development process. For example, we do not have a history of making meaningful decisions on release contents that have marketplace ripples. Same is true of tail end matters about adjustments to dates and patches. Our managers are not considered to be experts in making those decisions and yet are expected to carry the responsibility for making those decisions. So, there is a definite tension there. We have not created sufficient mechanisms to resolve these problems.*

The loss of control, threat of jobs, sense of inequality, and the designed interdependency have all contributed to the tension in the offshore R&D relationship dyad at VERITAS. Yet, the interviews indicate that some of this tension is constructive as it promotes a healthy competition between the two sites. The tension leads to the U.S. site trying to regain its supremacy and the Indian side to scale up its capabilities and performance. In that sense, the inherent tension results in a challenge for the both the teams and acts as a stimulus for them to stretch and grow in their quest for superior performance.

However, the newly introduced tension within the India organization as a result of demarcation of goals as product unit goals and 'India' goals is surely a cause for concern, but the India R&D General Manager has a well thought out strategy to make the two goals mutually supportive. He explained:

> *We need to align the component responsibility with India goals, and replace the operational tension with an existential tension focused on supplementing the portfolio. Until now, components*[6] *were started in the U.S. and later brought into India at the cost of resistance. We*

[6] Many of these components are sub-products of large products or small products by themselves.

> *must add to the portfolio by developing new components. Use components as the binding mechanism to bridge the tensions. But the key question is whether the component has a life or future, and thus whether the team has a life. So, I think, we have to go beyond an execution based existence to a component life based existence, and that should resolve the tension. I think there will be a transitional phase, where there will be a perceived mismatch between short team product needs and long term business needs. The real transition also requires a culture change.*

The new model of the India R&D organization, supported by an integrated management structure, is yet to express itself into any major competitive advantage for VERITAS. But a recent decision to grant the India Center its own budget for pursuing the 'India' goals is a sign that the company senior management is intent on levering India as a platform for winning the emerging market opportunities. Only time will tell how the confluence of senior management support and local leadership's vision and tenacity will shape the course of the VERITAS India R&D Center. But, in the interim, these structural changes in the autonomy and role of the India Center have added new dimensions in the already complex relationship dynamics.

6.1.3.3 R&D Task Allocation

An understanding of the model of engagement employed is necessary to understand how the India R&D Center of VERITAS contributes to the company's innovative capability and organizational flexibility. Any such engagement model essentially utilizes an approach for work allocation between locations, which also has a bearing on learning and knowledge integration. In this section, findings on engagement models and work partitioning from the VERITAS Offshore R&D case are presented to form the basis for subsequent discussions on specific constructs of interests to this study, namely innovation, learning and knowledge integration, and firm flexibility.

The interviews suggest that the approach to leveraging the India R&D Center by the various product R&D groups has been very fragmented, indicating an emergent rather than a deliberate strategy. This is also reflected in the pattern of work allocation for the India R&D center as is evident from the various interviews. Broadly three types of models have been employed at VERITAS for engaging its offshore R&D center in India: component ownership model, distributed development model, and the job shop model. In the component ownership model, the teams in India have been given end-to-end responsibilities for a specific component or product, whereas in the distributed development model the teams in India owned certain features of a product that they developed concurrently with other locations. The job shop model, which is gradually being phased out, involved tactically utilizing the India resource pool to augment staffing needs. Each of these engagement models has its own basis and utility, but it appears that there is an increasing preference for and adoption of the component ownership model.

The choice of a particular engagement model is driven by organizational needs and is determined by the R&D director who owns the budget. As such, each model has an underlying principle for work allocation. For example, within the VERITAS Cluster File Systems (CFS) group allocation of work across locations is around operating systems platforms. The CFS Vice President based in the U.S. explained his logic behind a platform-based engagement and work partitioning:

> *I treat my team as one team; I don't have the feeling that I have two separate teams. In order for us to work smoothly and seamlessly across borders, we need to have expertise on both the sides and also a good sense of teamness. However, even if it is one team and the communication is good, it is expensive. So, two people can't work on the same thing at the same time – it is difficult, especially if they are so far apart. So we try to segregate work in a meaningful way so that the distributed teams can work efficiently. So, one way to allocation work is to organize it along platforms, even though people on both sides have background in the same platforms. The other way is to distribute work by module ownership.*

Most informants felt that the ability to split work with loose coupling between sites is important because excessive interdependencies and oversight could be problematic. Yet, some product groups like the VERITAS Foundation Products follow more of a distributed development with considerable interdependencies, so a separation of work is somewhat difficult. In such cases, they end up having people on both sides working on a single project with interdependencies.

As things stand currently, in every planning exercise, the R&D engineers from India are involved and together with their counterparts in the U.S. they co-evolve the Market Requirements Documents. This is largely a collaborative exercise where each location's R&D responsibilities are determined. In most cases, the work allocation is done based on concentration of core competencies in one of the centers in a given geographical location. For example, India traditionally has had a good concentration of skills in the HP-UX area, so VERITAS products that need to be supported on the HP-UX platform are allocated to India. Increasingly, there is a belief within the company that platform based work allocation is the clearest way to organize, although all product R&D groups don't employ this philosophy in practice. There are many instances where work allocation is based on product features or full GUI development ownership across platforms.

However, in some cases, the allocation of work to India has simply been driven by cost considerations. A case in point is the recent decision to increase the footprint of Data Management Product R&D in India involving market leading product such as NetBackup, Backup Exec and Storage Exec. Interestingly, when the decision to move a significant part of R&D associated with data management products to India was taken, the required capability did not exist at Pune and new teams had to be ramped-up in an aggressive manner. This implies that the decision to re-locate work was not based on existing capability at VERITAS India R&D Center but was primarily driven by considerations of low-cost and scale of knowledge resources available. The data management R&D work programs are about transitioning of responsibilities at a component ownership level. So, the India R&D will be responsible for both the leading edge and the trailing edge of the work.

The pattern of work allocation varies across groups and is based on several considerations. For example, the Linux version of the VERITAS Cluster Server (VCS), which is a mature product, was fully developed and released by the India R&D Center. People in India already had some experience with the product. VCS Linux work was done on a common core and did not require any interactions with customers. However, the India team needed to coordinate with the release management function in U.S. Currently the India R&D team is co-developing the next generation VCS product with teams in Mountain View. They we have shared tasks and sometime when need arises, suddenly they are given a new task.

Similarly, for the VERITAS File System (VFS) product the scope of work has changed quite a bit over a period of time. Largely, the work partitioning has been platforms based. Earlier, the India R&D organization used to work on Sun Solaris, HP-UX and Linux platforms. Later, however, the R&D for the Linux platform was moved to the U.K. and the responsibility for the Sun Solaris platform was shifted to Mountain View, USA. Currently, the major thrust within the India R&D Center is on HP-UX and AIX platforms. This change was driven by emerging business priorities. There came a time when VFS on HP-UX needed more focus and rather than split the HP-UX activities across locations, it was decided to mobilize resources internally within India R&D to focus on HP and give up the Sun Solaris work. This decision was also based on a consideration that India R&D teams had deeper responsibility and accumulated experience on HP-UX and also a good OEM relationship with HP. The relevant hardware resources were also available in the Center in Pune. At that time, a team in Mountain View was working on the Sun Solaris platform in parallel, so they could take on that activity from India.

On the other hand, for the Volume Manager R&D, work allocation has mainly been based on features and not technology platforms. All major features lines are owned by the India R&D Center, whereas the ownership for all the major platform lines lies in Mountain View. A reverse longitudinal view on the evolution of the Volume Manager R&D activities in India suggests that the work partitioning has always been ad-hoc. The Dynamic Multipathing (DMP) Component of Volume Manager was done fully in India. It seems that the work was assigned to the India R&D Center because nobody in the US was available to do it whereas there were some free resources available in Pune. Later, of course, DMP became such a great success that it influenced almost 50% of Volume Manager revenues.

Still, in some other cases, the work allocation is based on the layers in the stack of a product line. For example, in the case of the corporate wide Integrated Data Management platform initiative within the Data Management Group, it was decided to allocate all the presentation layer and management layer (the two top layers) R&D work to India, whereas the domain layer and data layer (the bottom layers that involved system software capability) were allocated to Roseville. The hardware related as well as the domain knowledge existed in the R&D Center in Roseville, which could not be easily replicated in India.

Sometimes, the work allocation is simply a result of some organizational mandate. For example, the Shared Infrastructure and Security Development Group can currently hire people only in India and not in the U.S. due to a macro-policy within the company. And, in some cases, like for example the Certification Lab in Pune, the work has been largely tactical and the group has not grown beyond developing tools required for conducting the product certification process. It seems that establishing a group like C-Lab is investment heavy as it requires a variety of expensive hardware resources. There is also a consideration involving proximity to hardware vendors.

Although the product planning is often done collaboratively, the work allocation decisions are made by the locations where the product unit leadership is based. There is a certain dynamic associated with work allocation, as observed by a Director in Pune, responsible for the Storage Foundation Group:

> *We have healthy fights for grabbing quality work, but due to geographical separation the dynamics are different. If co-located, there would be a fair chance to fight, and so we have to make more noise to get good quality work. Later, we adopted a round robin mode of work allocation that allowed each side to pick their choice of work.*

While there are traces of the tactical, job shop model, there are two predominant work allocation patterns seen for engaging the offshore R&D center in India: one, component or platform or product stack layer based, and the second, feature based, which gets operationalized as distributed development tasks. The first one is ownership based and allows independence, whereas the second one requires deeper collaboration. Both the feature wise and platform based models seem to work, although the former requires significantly more coordination and control. Also, there are groups in India that work as extended team and perhaps don't match the technical work of their U.S. counterparts. They depend on the U.S. teams for directions and decision-making. Due to the primary driver being cost, the work allocation does not seem to be very systematic. It appears that by and large the India R&D footprints that have successful experiences are those in which work partitioning was done based on a strategic intent to leverage the talent, those which followed a ownership based or center of excellence based approach, not just the extended team model.

The senior director of the Data Management Group in India made a poignant observation concerning work allocation. Perhaps what he said reflects the reality in offshore R&D. He said:

> *The work allocation decisions have to necessarily consider availability of competencies and risk mitigation. Here is a bit of dichotomy: when you start two development locations simultaneously, each location can stake equal or fair claim to work. However, if one location came into existence much later, work allocation will follow a risk mitigation approach. How do you minimize risk? By pushing out work that is at the edges. That means, not the core platform work but the peripheral work. So, work partitioning will follow the principle of risk minimization. Of course, without the presentation layer*[7] *the product cannot ship, but it still is not the platform work. I see that dichotomy being played out again and again, and I don't know if there is a good solution to it.*

The remarks of a U.S. based Senior Vice President, who has been working with the India R&D Center for 8 years now, offer insights into the minds of the U.S. management as far as work allocation is concerned. Elaborating his response to my question on work allocation, he said:

> *My philosophy is to allocate responsibility based on the team's ability to be successful. I always challenge teams but I never want to set them up for failure by giving them work that is beyond their capability. With the teams in India, there was an evolution over time in their skills sets and their abilities to take on projects. I basically*

[7] Presentation layer refers to an upper layer in the product stack. For example, in the case of the Integrated Data Management product, the four layers that form the product stack include (in order from lower to upper) Data Layer, Domain Layer, Management Layer and Presentation Layer. Presentation layer work involves developing user interfaces, operating consoles, etc.

> *define four major phases in the evolution of teams in India. The initial phase involves becoming familiar with technology and building knowledge and credibility. In that phase, the teams have to prove that they can deliver on some tasks. The work items may be limited in scope – some features, product enhancements and sustenance. Then comes full product level work and understanding the associated level of quality required – enterprise class level. There was a bit of learning curve here for the teams in Pune – how to take a prototype and finish it to an enterprise class product.*
>
> *The second phase is where you have an established group with managers equipped to manage sizable teams – sufficient understanding of the development process and deep technical skills. In this phase, the teams take complete responsibility for releasing a product on a particular platform. By that time, the teams gain trust and respect. Comfort and relationships between the teams are established, a willingness to assign task is there -major pieces of a product, rather than a complete product. This stage comes almost after two years from the start and involves direction taking from us. The third stage, experienced management staff including second line managers, staff of up to 100 people. Broader responsibility, proposals, strategy setting and direction sharing, and customer responsibility. Responsibility for delivering full products and delivering them, although market requirements come from product management. The fourth phase, not reached yet, is a fully independent stage with a well-defined business and product agenda – subsidiary with profit and loss responsibility. Limited awareness of market trends but high awareness of technology trends.*
>
> *As the teams and experience grow, the ability to impact goes up. Access to markets and interactions with customers is the key to real success. Otherwise, it will become a "project house". It also depends on where the market is. Distance affects interactions. So more the teams are independent, the better it is. Complete product line ownership is an ideal solution. Pune is current in its third phase of the evolution and the distance from the market affects. I get a lot of ideas from them, but only a small percentage of them are viable or have market potential.*

Within VERITAS, now there is an increasing belief that the component ownership model driven work structuring is the best way to leverage the India R&D center as there are anecdotal evidences of the success of that model as far as product unit performance is concerned. In the component ownership model, the entire responsibility for the component, from the front end part of the process to product release resides in India. According to the General Manager for the VERITAS India R&D Center, data shows a strong correlation between employee retention and the work structuring pattern. In those product R&D groups where the work allocation followed component or platform ownership model the employee attrition rate was quite low as compared to the job shop model where the employee turnover rates have been as high as 50%. This was, it appears, due to a sense of ownership that got built up among the teams in India besides 'new' development work. However, he also acknowledges that history of the product also has an impact on such decisions. He said:

> *Component based work allocation is harder for those products that have been established for the last eight – ten years; it is much easier to do for products that are relatively new. A good example is the Storage Exec component, which is a whole product by itself, which is completely moving to India and is one of the fast growing products in the VERITAS products portfolio.*

6.1.4 Offshoring of R&D and VERITAS' Innovative Capability

This section presents findings related to generation of innovation by VERITAS India R&D Center and transfer of knowledge from the India R&D Center to the company's R&D Centers in the U.S.

6.1.4.1 Innovation Generation by VERITAS India R&D Center

Innovation is central to VERITAS's market competitiveness. The ability to relentlessly innovate, develop new technologies and introduce new products to address customer pain points in a timely manner is crucial for VERITAS. Moreover, technologies are getting commoditized and so it is necessary for VERITAS to differentiate through innovation. The company also faces the challenge to effectively resolve the innovators dilemma by not overlooking potential new technologies and getting trapped in existing products and customers.

The technical capability at the VERITAS India R&D Center has received its due recognition as is evident from its growing set of responsibilities across different product lines. The U.S. based executives unequivocally acknowledge that a good part of VERITAS' new technology has been developed at VERITAS India R&D Center. The teams in Pune have released entire products, contributed new ideas and developed new, market-impacting product features. They have suggested improvements and enhancements to the existing VERITAS products and added new features. However, they have not come up with new product concepts so far. Distance from customers and market is a commonly attributed constraint for the India R&D Center in not being able to contribute any major product innovation, although not everyone subscribes to this view. For example, in view of the Senior Director for the Data Management Group at the India R&D Center:

> *People here complain that their counterparts in the U.S. get more exposure to customers and markets, but it is a similar situation there as well. I think the needs of the customers across the world are same – world is flat. So we have as much potential to innovate as people in the U.S. do. We are the market leader in tape based technology. Disk based technology is the next thing, and we need to innovate here.*

The current customer base in India is still small and the organizational design does not mandate the India center to pursue market opportunities independently. As a matter of fact, currently all the market facing groups such as product management are located in the U.S.A. However, despite distance from customers and markets, VERITAS India R&D Center has generated a series of innovations, some with significant market impact. Interviews revealed that majority of the cases of innovation are incremental in nature, and there are more technological and product innovations than process innovations. Also, the scope for innovation generation seems to be driven by work allocation patterns and how VERTIAS U.S.A. engages the India organization.

There is a variety in the innovative contributions of the VERITAS India R&D Center. The case of the VERITAS Cluster File System (CFS) is particularly exemplary, which has been a significant innovation for VERITAS incubated at Pune. CFS, a file system that spans multiple hosts, was fully conceptualized and developed at the India R&D center. It appears that cluster file system as an idea was not new. But the CFS architecture conceived and developed by the India R&D Center included algorithms and performance that was a killer in the market. According to the U.S. based Vice President of the VERITAS Foundation Products portfolio:

> *The early prototype of the Cluster File System was done in India. The U.S. teams were non-believers of that technology. When I came on board, I was chartered to bring that product to the market for which I worked closely with India. India team was the early pioneer and contributor to the cluster file system technology as far as VERITAS is concerned. The product was launched in the market in 2000 and made available on many platforms over the next 3-4 years period and matured. This product really turned out to be a differentiator in the market for VERITAS. India is also playing a lead role in imaging technologies.*

CFS has traditionally been a market leading product but now other products are coming that are free. VERITAS therefore needs to make its customers feel that its product is worthy of their investment. So, the company has to introduce features in a timely manner that will allow it to differentiate its product in the market. Towards that the CFS Group has taken numerous measures, including setting up a Steering Committee that shapes the innovation needs of the product. Ideas are filtered through the CFS steering committee, discussed with product management, and when a prototype is ready, customers are approached for feedback. The CFS R&D team in India has filed a number of invention disclosure forms with the intention of obtaining patents. Many of these inventions have already been incorporated as new features in the CFS product. The India R&D team has also extensively automated the quality assurance processes that have resulted in an approximately six fold savings in testing efforts. Such effort savings obviously accelerate product development and release cycle times. Commenting on the CSF product, a U.S. based Vice President said:

> *CFS work was done fully out of India with extensive involvement of senior technical architects from USA. The work was felt to be ahead of the market. So, if you look at it, the innovations the India team produced were completely in future looking areas. CFS is a very complex product. I have not seen any CFS making money, but we were able to commercialize.*

There have been numerous occasions when the VERITAS India CFS R&D team has been called upon to stretch itself and deliver on customer needs. For example, for the HP-UX version of CFS, the project timelines were rather short. This release was the first CFS HP-UX release involving multiple external parties. The Pune team had to synchronize processes between VERITAS and HP. On the QA testing side, they developed a way of setting up a test framework where testing could be done without the VERITAS product. These may not be any major innovations but on the other hand, with such creative measures meeting the business objectives would not have been possible.

The percentage of total resources allocated for innovation in the CFS product is growing at India R&D Center with a view to develop new, differentiating features. Yet, the managers on both the sides are of the opinion that there is nothing unique that the India R&D center is doing. However, there is one advantage, though. And, that is that unlike other R&D locations that focus only on a particular product line, the India R&D Center houses almost all the VERITAS product lines. Such co-location with other groups allows for better cross fertilization of ideas within the India R&D organization and helps address issues related to integration with other products with which the CFS product has an association. In addition, such co-location also allows the advantage of the same time zone leading to improved coordination.

Another major innovation that came out of the India R&D Center was the development of the Dynamic Multipathing Technology (DMP) for the Volume Manager (VM) product. DMP was conceived, architected and developed completely in India and this technology doubled VM license revenues on all platforms ever since its release. A Technical Director at the India R&D Center, who was involved in the DMP technology and feature development for Volume Manager, provided a vivid account of how this innovation came about:

> *Back then, I was involved in Volume Manager R&D. At that time, the idea was essentially floating in the U.S. at the hint of Sun Microsystems. The shortest time the U.S. team gave to develop this feature was one year, whereas we came up with a three-month schedule. Alex Charles, the then VP for Volume Manager, one fine day landed in Pune and said, "If you guys can do this work in three months, I will give the work to you and incentivize you with stock options." We delivered the DMP component in three months and, of course, made a lot of people in M.V. unhappy because of our aggressive posture. What we did in DMP, in support of disk arrays, was a completely new layer to VM.*

Interestingly, for the DMP work, the only requirement the India team received was very broad: "we need to support disk arrays." And, many things that the India team did were not even a requirement. For example, they wrote a controller that could disable multiple HP-UX hosts connected to server through software for maintenance purposes. Later, the work the VERITAS India VM R&D team did for DMP became an industry standard. The DMP component makes VM to be hardware agnostic. Recent surveys indicate that 47% of the VM customers buy the product because of DMP. Later, DMP also became a key product for VERITAS storage management products. Similarly, a team at India R&D introduced a new feature - Rolling Upgrade, in the Volume Manager product that would permit upgrade of a particular node in a high availability cluster environment while the services were on. This facility was perhaps unique in the market.

The DMP component for Volume Manager and the CFS are some major innovations the India R&D has produced for VERITAS. However, there are other significant examples of innovations from VERITAS R&D. For example, three to four key features of the Cluster Server System, which is one of VERITAS's market leading products, were done by the VERITAS India R&D Center, including the complete graphical user interface that resulted in a significant marketplace impact for the product. Likewise, the

India R&D team came up with new ways of persisting storage in the VERITAS Cluster Server (VCS) product, developed a new abstraction layer for configuration management, and also introduced a brand new way for product installation and rolling out upgrades. The India team also developed a Web-based API (Application Programming Interface) for connecting with the product. The VCS India R&D team also radically improved the user interface of the product, which resulted in a significant marketplace impact. Interestingly, user interface being a front end work, initially it was felt that the India R&D team won't be able to deliver on it given they were away from customers.

Some of these innovations came about because the new product architecture required it, whereas some others were worked upon because of customer requirements. The team also innovated ways to minimize overheads that arose due to enhanced security measures, and this helped improve product performance. The VCS India team did test automation and developed test framework in order to improve QA testing effectiveness. They also developed a test management tool that helped with cross-platform test automation. Such a tool was crucial for the project but not available from the market. The test management system allows for better planning and coverage in addition to 25-30% cycle time improvement due to automation. This test management tool was later adopted by Mountain View.

The other R&D groups at VERITAS India R&D Center also have examples of innovative contributions. Take for instance the Allocator component for the Volume Manager product being developed out of India. Allocator is a forward looking work for intelligent storage provisioning and allows hierarchical storage management depending on performance requirements. The idea for Allocator came from a U.S. based architect but it has been designed and developed by a team in India. Allocator is supposed to be quite innovative from a technology point of view. However, unlike other cases, its commercial potential has yet to be seen. Another instance is that of Windows-based clustering and replication, which was not thought to be important within VERITAS and the U.S. based Vice President in charge had resisted the idea. But the India team persisted with its proposal to develop a Windows based clustering and volume replicator product and succeeded, perhaps because of low cost involved in experimenting with it in India. Now, however, the Windows based clustering and replicator products are generating a lot of revenues for VERITAS.

Another case in point is the FMR feature – a major innovation for the Volume Manager product that was developed by the India R&D Center. Other leading examples include the Space Optimized Timeshots feature for Volume Manager that was completely done out of Pune. Initially, people in the U.S. had resisted the design proposed by the Indian team. Later, this new feature done from India became an enabler for a lot of emerging technologies like virtualization. In fact, both the space optimized timeshots technology and the allocator product were recognized by the invention of the year awards within VERITAS.

The India R&D Center also recognized an opportunity to address VERITAS' competitive needs through better user interface design. A senior manager at Pune noted:

> *We are a technology focused company, so generally our User Interface (UI) design is rather weak. We see momentum in the market and release products without adequately addressing the UI related aspects. Usability gets focus only after first three to four releases. As a result, the technical support calls are high which costs us money.*

The then local Vice President of VERITAS India R&D championed the idea of setting up a User Centered Design (UCD) group at Pune, who saw potential in the proposal that was submitted by an employee with industrial design background. The UCD group now has 20 people and works across VERITAS product groups to help develop software products that are easy to use, easy to learn and easy to maintain. This group essentially represents the voice of the end customer. After this group was set-up, a lot of front end work (work pertaining to the user interface layers of products) moved to India. UCD has had huge impact on VERITAS. The tech support call rates across product have seen a decline, saving significant cost for the company and contributing to its bottom line. VERITAS products have also received high ratings on usability from analysts, thereby improving their market perceptions. Spurred by the success of the UCD group at Pune, a similar group was later set-up in the U.S. Today, the India teams focus on usability design whereas the team in the US focuses on usability evaluation and testing. UCD became a major organizational innovation within VERITAS.

Interestingly, it appears that since there was reluctance among the U.S. based teams to part with core platforms related work, UCD gained acceptance because it would involve working at the higher layers of the product to improve their usability – something very much desired by VERITAS. On one hand, setting up of the UCD group in Pune influenced the inflow of work to India and on the other hand, it also helped build acceptance and credibility of the India R&D teams amongst their U.S. counterparts by virtue of their performance on the work allocated to them.

Similarly, the VERITAS India team found that the field escalation support from an engineering point of view was quite was disruptive. So they decided to install a dedicated support and escalation team called Current Product Engineering team. This approach has now become a way of life in the U.S. as well, as opposed to the earlier practice of assigning engineers on a rotation basis for escalation support. The new approach has improved effectiveness, built rapport with technical support team, allowed for systematic learning, and improved response times.

Like technological and product innovations, there are traces of process innovations, too, at the VERITAS India R&D Center. Across the product groups, there is evidence of efforts to streamline processes and taking the wrinkles out of it. Notably, the teams in India have developed effective testing approaches and automated quality processes by doing test case automation. The India team developed and introduced a metrics-based approach for managing product and process quality. These were new to VERITAS. Managers at VERITAS India R&D Center take pride in their process innovation contributions, as is exemplified the following remarks of a manager in Pune:

> *We infused a quality mindset in VERITAS, which otherwise had a typical development mindset.*

However, all the process innovations are incremental in nature and it appears that, unlike the product and technology innovations, most of these process innovations have not had any major impact on company's business performance.

There is a dominant view across VERITAS that while India offered low-cost, high-scale talent pool, the real purpose in growing the R&D footprint in India was to expand R&D capacity and enhance innovative capability for VERITAS. A Vice President in the U.S. that I spoke to said:

> *The founders were frustrated with the pace of innovation within VERITAS. So, they incubated the R&D Center in Pune with the hope that the India will become a hotbed for innovation for VERITAS.*

The leadership team in India wants to just do that – leverage the vast talent pool in India to turn the R&D Center as a crucible for innovation and growth of VERITAS. There is recognition of this expectation within the VERITAS India R&D Center. Several new work programs are being moved to India, the recent one being several components of the various products in the Data Management product lines. Many of the data management products such as Backup Exec and NetBackup have existed for years and need to be reinvented and repositioned in line with new technologies. Such business needs present opportunities to the India R&D Center to innovate. For example, currently most of the data management products use tape based technology which has matured and there is increasing adoption of the disk technology. Currently, the India center operates as an R&D outpost rather than a full-fledged unit, so the issue of proximity to major customers and markets won't disappear anytime in the near-term. To make up for the lack of customer interactions, the teams in India have tried alternate ways to derive customer insights including analyzing escalations and support requests. However, the India R&D Center hopes to leverage its distinct position for generating innovations for VERITAS. The senior director for DMG at the India R&D Center explained:

> *Some of the teams in the U.S. have been with the product too long. That is both good and bad. Good, because they have rich, extensive experience with the product and bad because they are vested in the old ways, suffering from rigidity and inertia. Whereas, we due to our growing experience, are able to bring in fresh perspectives and innovative ideas.*

The India R&D center, over the years, has gained deep knowledge about the various VERITAS products and the team members have built a wide social network with various stakeholders including their counterpart R&D engineers, product and program management, and the sales and technical support organizations. This has resulted in better information flow and exchange of ideas. The inclusivity of the VERITAS India R&D Center within the company has also improved substantially. Compared to before, the R&D team in Pune can better understand the contexts and problems so as to direct their innovation efforts in a systematic way. Yet, distance from the center of gravity affects, as this Engineering Manager in Pune explained:

> *Access to right people, understanding the problem, and access to right information are crucial for us to innovate. We need information on how customers use our products, in what configurations, etc. We have constant flow of information from product management through an alias list. The U.S. teams have a head start over us because they are in proximity to Product Management and can walk over to each other's office for discussions. In fact, by the time information reaches us, or my U.S. colleagues speak to me, I find a lot of thinking has already happened and that a view exists. And, I have to start from there. A lot of innovation happens because you are trying to solve a problem and the U.S. teams have an advantage here.*

The VERITAS India R&D Center is already doing a significant chunk of R&D and the center's responsibilities are likely to expand in response to the demand for more R&D capacity and growth. The scale of available talent and the cost factor certainly favor the India R&D Center. The U.S. based managers don't believe that the India Center has produced any major innovations yet, but they acknowledge that there is a culture and hunger for innovation. If there are interesting problems to work on or tough challenges to address, the teams at the India R&D Center are willing to stretch themselves in response to the challenges. The Engineering Manager for DMP in the Volume Manager Product group in Pune shared an interesting incidence:

> *We are always willing to take on additional work. One of the senior VERITAS executives of Chinese origin, who came here, asked me, "Tell me, you never say no to any work proposal. How it works?" I said, "If we have an interesting problem to solve, we don't mind spending a few extra hours at work." To which she remarked, "Oh, I now understand how it operates – you actually have young entrepreneurs here."*

The India Center has been very selective about hiring people. As a matter of fact, more than 70% of the hires at VERITAS R&D Center in India come from the Indian Institutes of Technology or the Indian Institute of Science – country's premier technical institutions. There is also a growing innovation culture at the VERITAS India R&D Center as is evident from the number of invention disclosures filed by the center. In 2004, 40% of the total invention disclosures counted at the level of VERITAS Software Corporation came from the India R&D Center in Pune. In fact, since the last 3 years the rate of per capita patent application filing is higher in Pune than any other VERITAS R&D Center. But the senior managers at the India Center recognize that patents are not a true measure for innovation. Instead, they believe that their R&D performance should be measured in terms of influence on Market Requirements Documents, ownership of critical components, level of product support ("Are we on the critical path?"), new product incubation, product cycle time acceleration, and operational efficiency (volume of content/per scheduled release), etc.

Currently, the India center is more of an R&D outpost than a full-fledged subsidiary with profit and loss responsibility. So, typically, India is the preferred destination for prototyping of new product ideas or technologies because of its low cost talent pool advantage. Going forward, it appears that that there will be a heavy concentration of experimentation activities at the India R&D Center, which would include incubating new products, besides growing product R&D responsibilities.

6.1.4.2 Knowledge Transfer from VERITAS India R&D Center to VERITAS R&D Centers in U.S.A.

Dispersion of R&D means dispersed learning and knowledge generation. In the case of VERITAS, this is no different. Integrating the dispersed learning and knowledge is a challenge that global firms need to address because effective integration of global knowledge determines firms competitiveness, especially in case of R&D intensive technology firms. To that extent, an examination of learning and knowledge integration in the context of VERITAS' offshore R&D is important.

In the case of VERITAS offshore R&D, learning and knowledge integration assumed different dimensions depending on the work partitioning model employed. In the case of component ownership based or competency based work allocation, since all the work on specific components or competencies happens in VERITAS India R&D Center, naturally all the associated learning and knowledge generation also takes place there. In the case of distributed development model of work allocation, which is characterized by high interdependencies, both the involved locations work on the same product or components. In such a case, there is mutual learning and co-generation of knowledge. In the third, job shop model of work allocation, which involves tactical resource arbitrage at the offshore R&D location, the focus is usually on task fulfillment or resource augmentation and so learning and knowledge creation happens in a rather ad-hoc manner.

While there are an estimated 30% cases of job shop model at VERITAS India R&D center, a majority of work follows either the component ownership model or the distributed development model. It is readily understandable that in the case of the tactical, job shop model the assimilation of learning and integration of knowledge across locations will be compromised. It is also conceivable that in the distributed development model, the exchange of learning and knowledge will be simultaneous and frequent given the close coordination and communication involved. Whereas in case of component ownership model or competency-based work allocation, there have to be systematized ways of facilitating learning and knowledge integration. Irrespective of the work structuring model being followed, given that many product units have nearly 50-60% of their R&D resources located in Pune, assimilation and transfer of learning and knowledge from the offshore R&D center in India to other overseas locations assumes critical importance.

In the VERITAS offshore R&D engagement, learning and knowledge sharing happens in many ways. At one level, there are firm level committees such as global patent committee, global architects committee and the like. A lot of learning and knowledge gets disseminated by way of IDFs (Invention Disclosure Forms), which also lead to formalization of learning and knowledge. Learning and knowledge sharing also happens through feature and solution proposals that flow across locations. Then, there are VERITAS wide forums like Cutting Edge, which are held at regular intervals and provide a platform for learning and exchange of knowledge. People engage in formal weekly calls to discuss project status and exchange ideas. Team members from both the locations also undertake extensive travel to meet and interact with their counterparts. Moreover, each R&D project carries out a ‘post-mortem’ of its projects to capture the learning and disseminates it through documentation.

Another key to knowledge sharing and integration is VERITAS' job rotation policy under which anyone who has spent four years at VERITAS India can choose to work at any other VERITAS R&D center. Many people opt to capitalize on this policy with a view to obtain better professional exposure, but it also leads to learning and knowledge integration through socialization. Besides, within the offshore R&D center, people are moved from one project to another to staff the needed capability for new projects but also to leverage accumulated learning from the past. Across the product groups, there are frequent phone calls and email exchanges, suggesting that the density and frequency of communication between the offshore R&D center and its counterpart locations are quite good. Moreover, VERITAS also extensively uses technologies like Intranet to facilitate information flow and exchange of learning and knowledge. Several managers talked about the fact that regular communications between locations helped build a sense of involvement and served as a binding mechanism. To quote one Vice President of the VERITAS Cluster Server Product Group based in the U.S.:

> *We communicate profusely and spend a lot of time on massive communication. Our call frequency and density are very high. Plus, we travel extensively. When people from Pune come to Mountain View, they participate in all the meetings they can and meet with people. Ditto for Mountain View people when they visit India – their schedule is jam packed, meeting people and interacting with them. For key strategy sessions, we invite people from India. A working relationship is important.*

However, most U.S. based managers expressed a common concern that has to do with excessive mobility of the people in India for career reasons. The Vice President for the Storage Foundation Group based in the U.S. observed:

> *The risk of turnover is high in India. The last person you would like to lose is someone you have trained for 2 years and who has now just begun to become productive. In India, people are impatient for career advancement.*

When the India R&D Center is allocated work based on platform or component ownership based models, it results in concentration of certain skills and learning and knowledge in those groups in India. This learning and knowledge has to be integrated within the larger VERITAS ecosystem to be leveraged for business benefits. Consider the case of VERITAS Cluster Server (VCS) Product's Linux Platform version, which was fully developed out of India. Interviews with the VCS team suggests that in the VCS Linux project, there were a lot of technical and process related learning given the new and dynamically changing world of Linux. The teams in India had to share the learning and knowledge with teams in the U.S. for the purposes of customer support, even though it appears that this sharing was more informal and experience based.

When the India R&D teams started working on products like Volume Manager (VM) and Cluster File Server (CFS), not only they did not have access to anyone locally who understood the products but also there were no documentations available. VM and CFS are extremely complex products and lack of documentation made the task of R&D engineer quite challenging. They had to decipher the needed knowledge by reverse engineering the code. In doing so, they created elaborate documents and training manuals for training people at India R&D Center. In the whole process, they codified the entire product knowledge, which is not in the VERITAS corporate memory as explicit knowledge.

Conceivably, since the core R&D teams as well as the original teams continue to be in the U.S., a rich knowledge base already exists there. However, in the wake of a growing resource and activity concentration at the India Offshore R&D Center, a two way learning and knowledge transfer assumes significance for VERITAS. While, traditionally a lot of knowledge has flown from the U.S. centers to the India center, given the critical mass of knowledge assets in India, a reverse transfer of learning and knowledge from India to U.S. is important. However, the reverse flow of learning and knowledge seems to be rather weak. Most India based managers attribute this to a management attention deficit on and some sort of superiority complex among their U.S. counterparts. Some others believe, however, that their learning and knowledge has to be really significant and valuable for their counterparts to be interested in learning from them. An India-based Technical Director, who is well-recognized within VERITAS, observed:

> *For learning, the willingness and attitude matters. And, often the only inhibitor to learning is their bias. Of course, people have to know you to learn from you. When someone listens to you, you respect him. I would like to work with people who contribute to my knowledge, and vice versa. Also, you have to be anointed as the lead by the management. Managers play a big role in facilitating the learning.*

Another Principal Architect at VERITAS India R&D Center, who shares very productive relationships with his counterparts in the U.S., remarked:

> *Learning and knowledge sharing is a two way channel. You need to reach a point where you can earn their respect. They have to believe that if they bounce off an idea with you, they will receive insightful perspectives.*

While both sides believe that they need more face-to-face interactions, which requires travel, to build networks and engage in discussions, they complain that often travel becomes a constraint because of budgets.

When the India center grows to have its own budget and mandate, and innovates to serve local and neighboring markets, integration of learning and knowledge from India into the U.S. R&D centers will become crucial. The most important learning and knowledge will involve market and customer insights, complementary insights from the regions VERITAS India will serve. Then, the company will need to install mechanisms to share such complementary insights.

6.1.5 Offshoring of R&D and VERITAS' Organizational Flexibility

In this section, the influence of VERITAS India R&D Center on the organizational flexibility of VERITAS within the bounds of the R&D organization is discussed. From the preceding discussions on work partitioning it is clear that there is an element of operational flexibility that the India center enables for VERITAS. For example, the job shop model of work allocation, which seeks to tactically leverage resource pool, also leads to operational flexibility for the product groups. Similarly, the platform ownership based work allocation also has an element of operational flexibility inherent in it since it appears that the responsibility for the operating system platform has changed a few times during the course of the India R&D Center's existence. In fact, product groups such as NetBackup that added more than 150 engineers over a year to the R&D team in Pune suggest an element of operational flexibility the India R&D organization offers by ways of its quick ramp-up capability. Several U.S. based managers readily acknowledge the value of such operational flexibility. For example, the Senior Director for the Shared Infrastructure and Security Development Group in the U.S. observed:

> *We need to be able to adapt to changes…We have had occasions when we needed some extra work done and the Pune team rose up to the occasion. Cost savings are a big source of flexibility – we could do more with the budget.*

However, the India R&D Center also contributes flexibility to VERITAS in many strategic ways. At a macro level, the India R&D center offers a young and energetic talent pool that brings in fresh ideas and perspectives. The India team also brings in knowledge in new areas such as new operating systems like Linux, which was not available within VERITAS in the U.S., and deploys that for product innovation, as in the case of VERITAS Cluster Server Product on Linux, which was developed in India. There is also evidence that VERITAS India provides high quality resources to carry out prototyping of new ideas and concepts and develops them for integration with products. Likewise, when products are required to be ported on new platforms due to emergent market and customer requirements, VERITAS Software Corporation relies on its India R&D Center to meet such goals. Such capability to effectively address emergent priorities is crucial for VERITAS as testified by its U.S. based Vice President for the VERITAS Cluster Server Product:

> *We need to adapt quickly because either competitors are changing tactics or because the partners can quickly turn into competitors. In many ways there is a race, and we need to be able to quickly ramp up projects or move projects across locations to free-up resources for new projects. Flexibility is extremely important; having a larger resource pool adds up to flexibility – everything is related to resources. Clearly, you cannot change a GUI engineer into an OS engineer, so you have to shift people within the constraints of what they are good at. I think having a well-balanced resource pool on both sides adds to the flexibility because it gives you a degree of freedom. In fact, the cost differential allows us to take more risk at less cost.*

A key issue for R&D success is accelerated product cycle time. VERITAS often needs to make a trade-off between product features and release time. Because of the larger team size in India, the company is able to shuffle resources to deliver more features in a given release. This obviously strengthens VERITAS' market position.

Flexibility is inherent in VERITAS India R&D as it appears to be part of its organizational fabric. Consider for instance the case of the VERITAS Cluster Server (VCS) R&D group in Pune. At one time, when the India team was busy working on with VCS AIX product release, suddenly the Product Management needed to have the product available on HP-UX. The India team readily shifted gears to deliver on the requirement. An Engineering Manager of the VCS R&D Group in India observed:

> *People here are quite flexible. I think as an organization we are quite flexible. As long as we understand the change, we are able to accommodate the change.*

Similarly, the VERITAS File System (VFS) R&D Group in Pune has on many occasions responded to emergent priorities by re-allocating resources. For new market requirements, the VFS India R&D team has joined hands with their U.S. counterparts and done parallel development to accelerate products to market. The U.S. managers also readily acknowledge the cultural flexibility VERITAS India as an organization offers as is testified by the following admission of the Senior Director for the Shared Infrastructure and Security Development Group, who has a substantial part of quality assurance (QA) related activities located in Pune:

> *Being QA, they receive things towards the end of the lifecycle by which very little time is left for release. Still, they know the bigger goals and adapt themselves for the challenge.*

The interviews suggest that the VERITAS India provides scalable, high quality talent pool that is young, energetic and demonstrates high learnability. The India talent pool is adaptive and quick to acquire new skills in new technologies. As a result, the India R&D Center is able to provide VERITAS with a flexible innovative capability that is crucial for its competitiveness. India is doing 24/7 technical support for Back-up Exec - 300 million US dollar stream, done almost completely from India). This is different from what is done by the other leading product vendors like Oracle or Sun, who run three shifts from three different geographical locations. The goal of technical support is to achieve high customer satisfaction at low cost and by concentrating both the product development not only is VERITAS able to provide better customer support but also ensuring circulation of learning and knowledge. The operational flexibility in the sense of resource ramp-up and down for tactical work is gradually diminishing as the India R&D center is increasingly negotiating its preference for ownership based work allocation. With an unchanging core that is getting established as the operating model at VERITAS India R&D Center, the staffing flexibility is eroding due to the inherent nature of the organization.

6.1.6 Impressions from VERITAS' Offshore R&D Engagement

Today, the VERITAS India R&D Center is key location for VERITAS R&D activities, housing as much as the company's 60% of R&D activities across product lines. Yet, the center is not a full-fledged R&D center pursuing its own product-market mandate having its own budget, although that is likely to change over the next year or so. Over a period of time, the India center has established itself as a location for highly capable technical talent pool, which can work hand-in-hand with its U.S. R&D centers to produce innovations for VERITAS. Many view the India center as a lever for the company's future growth as it provides low-cost R&D capacity to VERITAS. However, for that to be fully leveraged for VERITAS, the India center has to have full autonomy and move away from being a remote development center to be able to contribute to the company's top line growth. A remote development center, all said and done, is helping the current revenue streams associated with the products and innovating within those revenue streams.

Currently, the engagement structure resembles a mother-daughter relationship and by and large seems to be tightly managed. While the India R&D teams at large have local freedom they do not have their own budget and R&D agenda. Instead, R&D work is allocated to them by the U.S. based product groups along with the necessary budget. The teams in India report to their counterparts in the U.S., who own the budgets and drive product technology roadmaps in most of the cases. All product features and release related decisions are also made by the teams in the U.S. The work allocation also delimits the scope for generating innovation for the India team. If the work allocated is such that it is well-defined, then the India team's job gets reduced to execution. Of course, in executing such work, a lot of technical and design level innovation is possible which impacts product performance or leads to a more efficient ways of doing things, as is evident from many instances found in VERITAS India R&D center. On the other hand, when the VERITAS India R&D teams received a problem to be addressed, or were challenged with a business requirement, their R&D outputs have been innovative and greatly impacted the business performance. Cases in points are the VERITAS File System product or the Dynamic Multipathing technology for the Volume Manager product.

Findings from VERITAS show that R&D performance and innovation outcomes have been better when the India teams were allocated work by assigning ownership of products or components. In such cases, the autonomy available to the India teams has been relatively higher. But, it appears that challenge also catalyzes innovative outcomes. In the case of VERITAS, challenge seems to stem from the tension that exists between India and the U.S. R&D Centers. For the U.S. teams, the sources of the tension are lack of visibility, loss of power, partitioning of work and the potential threat of jobs. For the India teams, however, challenge is about proving themselves and their capabilities, ascertain equality, and often this involves stretching themselves. However, if the result of such existential tension is an enhanced R&D capacity and innovative outcomes, then it suggests that such a tension is constructive in nature. Some senior managers in the U.S. recognize the need for the India organization to operate with more autonomy and attain a peer level status, as the Vice President for the VERITAS Cluster Server R&D based in the U.S. says:

> *If there are good, dedicated people, and if the Corporate invests money in developing an environment where people feel good, have a sense of equality and peer structure, they deliver extremely well. On the other hand, if people somehow feel that things are not fair, that they are getting only uninteresting work, they are not motivated and they don't deliver well. Value add of people at Pune also depends on organizational commitment – do they have budget ownership, are they being micromanaged, are they participating in customer visits.*

The India R&D Center has a wide R&D footprint across VERITA product lines, which is not the case with the other R&D centers in the U.S. or Europe that perform R&D for specific product lines. That way, the India center has the opportunity to generate future innovations for VERITAS because integration across the various products is now high on the company's R&D agenda and co-location of the various R&D programs in India can facilitate such integration. Several U.S. based executives agree that India R&D works to advantage because of the time zone difference, which allows 24 X 7 engineering and customer escalations support. Around the clock development allows VERITAS to deliver products faster to the market. Within the VERITAS context, innovation requires a lot of researching and prototyping, and the U.S. based managers believe that because of Pune there are able to expand their R&D capacity and develop new ideas and prototype them at low cost. Because of the inherent uncertainty associated with R&D and innovation projects, low cost, high-quality resource pool that Pune offers has a direct bearing on VERITAS' competitive advantage. According to the Vice President of the Cluster Server Product R&D Unit in the U.S.:

> *The indisputable value-add of the India center is that for the same budget, we are able to get more people. The difference is that you have larger pool comprising younger people, who have ideas and energy. Pune people are able to explore new ideas and take initiatives to improve the products. The bottom line is that we are able to try new and more ideas irrespective of where the idea originates. A younger team thinks out of the box.*

Another Vice President, who is responsible for the VERITAS Foundation Products R&D, based in the U.S., believes that a low-cost R&D center has a direct impact on firm's business performance. He observed:

> *India contributes greatly to our operating margin. That's cost arbitrage. But, actually, the Pune center gives us access to some of the best minds, which undoubtedly boosts the VERITAS intellectual capacity. We are able to achieve reduction in time to market due to round the clock development and provide round the clock support to customers. Of course, this needs to be carefully managed to strike a balance between round the clock development and the delays caused due to coordination, which requires close communication and clarity of roles and responsibilities.*

What is striking though that despite a significant resource concentration in India, VERITAS does not have any structured criteria for evaluating the contributions of its offshore R&D center in India. Although there are such measures as percentage of invention disclosure forms that India contributes, there are no formalized performance measurements. At each product R&D group level, the performance parameters is understood to be "do well what we are supposed to do, deliver products with high quality and on time." But within the India organization, in keeping with its vision to become a full-fledged VERITAS center impacting company's top line performance, the local leadership is trying to install a structured evaluation system along three dimensions for its portfolio of work: execution leadership (cycle time, quality), product innovation leadership (killer features or revenue generating features or supportability features that reduce the cost of support to improve margins), and roadmap leadership (2-3 year roadmap for the products/components). At the time of this case study, such a measurement system was being piloted within VERITAS India for the Data Management R&D Group.

Social ties are strong between the members of VERITAS India and their counterparts in the U.S., and this has significantly improved circulation of information and learning and knowledge transfer. Formal communication mechanisms like weekly telephone calls combined with informal exchanges facilitate learning and knowledge transfers. In addition, invention disclosure forms and feature proposals are other prevalent means of knowledge capture. While technological, process and product related learning and knowledge transfer is supported by many of the above mentioned formal and informal means, the offshore R&D engagement has also built substantial knowledge about management of global R&D. The reverse flow of learning and knowledge into the U.S. is an important management task for VERITAS given the growing resource concentration in India. As it appears, there is no sign of an explicit management action to capitalize on such learning and knowledge being generated from India. Much of the learning and knowledge capture is either push based (documentations, etc.) or through social interactions, and is usually left to interested individuals. Of course, a lot of new learning and knowledge is integrated in the products or components the India R&D teams deliver. The senior executives I interviewed agree that the collective leadership has a role to play in catalyzing the learning and knowledge transfer but there is no evidence on the ground that shows any concrete leadership action on this front.

There is evidence that VERITAS India R&D Center enables organizational flexibility for VERITAS in a significant way. Although, in some sense the operational flexibility is limited, strategic and structural flexibility enabled by the VERITAS India R&D Center is high. The low-cost innovative capacity that is provided by the India R&D Center to carry out innovation related activities such as prototyping, new ideas exploration, etc. offers significant strategic flexibility. At the same time, the ability to put together a cross-functional team to explore new opportunities, or accomplishing integration across products due to co-location of various product R&D groups, offers considerable structural flexibility. Finally, it appears that the demographics of the workforce in India, coupled with their need to prove themselves, bring into play certain cultural flexibility that benefits VERITAS by way of a flexible innovative capability.

The evolution of the VERITAS' R&D Center in India is a good case to understand the structure and dynamic involved in offshore R&D. It demonstrates that if managed well, an offshore R&D center could be a significant source of innovation, learning and knowledge creation, and flexibility that a technology-based firm needs for its competitiveness. This case also shows the impact of leadership on both sides in shaping the evolution of offshore R&D. Clearly, the employment of the job shop model results in a fragmented R&D footprint because each group in the U.S. runs their own extended India teams and by virtue of that the organization fails to derive the benefit of critical mass. Given that, like many other companies, in VERITAS also there is an increasing scrutiny of R&D budgets and focus on improving operating margins, not strategically leveraging the offshore R&D center in India will result in a competitive disadvantage for the company. The VERITAS India R&D general manager shared his perspectives on how to strategically leverage an offshore R&D center in the context of VERITAS:

> *In the remote development model, it is really an ability to provide competitive advantage to the organization. Take the stage where the product is in. If it is in the early stage, then by finding reference customers in Asia Pacific region and co-creating the product with reference customers in the region. This can be 'make or break'; we have seen this play out in one of our products, CC Server. If the product is past the chasm stage, then accelerate the revenue growth by incremental R&D and by improving the margins. A good example is Storage Exec – a hyper growth product that we moved completely to India to maximize profitability over a period. In case of a late stage product, add value by reinventing the product by dramatically lowering the TCO if it is an enterprise product. This requires a new focus on usability, manageability and feature sets, transformation in support delivery model for the product. This constitutes the remote development value proposition, which is about improving competitiveness. However, in future, there will be other opportunities to bring products for the mid tier markets, which can be served by leveraging the knowledge already, gained, which will be about creating new products.*

The low-cost talent scale in India has worked out to a significant advantage for the company. First of all, VERITAS operates in a market, which is increasingly cost conscious. Given that the capabilities offered by many of its products are supported by native operating systems like UNIX, Windows and Linux, VERITAS has to approach the market with a compelling cost-value proposition with its products. Second, since its market success depends on its ability to keep pace with new operating system releases by different vendors, VERITAS needs the talent and scale to produce in a timely manner its products on different platforms. The comparatively low cost structure in

India, which is roughly 1/3rd to 1/4th depending on the level of positions, adds to VERITAS' bottom line, addressing the company's need for cost competitiveness. Also, skilled talent base allows VERITAS to expand its R&D capacity and have the flexibility to respond to market and technological changes in an efficient manner without incurring excessive costs.

VERITAS R&D Center is a classic example of offshore R&D, which has evolved from having a completely emergent strategy to a more deliberate strategy through self examination and diffusion of learning and experiences. The views of the U.S. based managers is shared equally by the leadership in India that ultimately if the India Center has to be a crucible for emerging markets, there has to be market and customer insights that has to deeply start permeating the organization than it is today. Currently plans are afoot to award the India center autonomy with its own budget. The leadership in India is steering the Center in the direction of a full-fledged center. For that to yield results, though, the India center will need to have people who understand customers, markets and business. And, this means that the culture in Pune, which has been predominantly a technology culture, needs to change, too.

6.2 CASE STUDY II: SAP A.G.

SAP is the world's largest business software company and the world's third largest independent software provider overall. In 1998, SAP established a research and development (R&D) center in Bangalore, which has since then grown to become its second largest R&D center. Known as SAP Labs India, the India R&D center is one of the ten global R&D Labs and caters to the full value chain of SAP. It contributes nearly 20% of global R&D and services and support, and has over 3000 employees. I interviewed several people at SAP Labs India and Germany to understand of how SAP Labs India contributes to SAP's need for innovative capability and organizational flexibility. Table 6.3 provides details of the interviews that informed this case study.

6.2.1 Background and Context

Founded in 1972 as **S**ystems **A**pplications and **P**roducts in Data Processing, SAP is the world's largest business software company and the world's third largest independent software provider overall. Its mission is leverage technology to empower enterprises to adapt quickly and flexibly to succeed and grow. SAP employs 39300 people and offers a comprehensive range of technology-based business solutions across industry segments to empower every aspect of business operations. The company has operations in more than 50 countries and serves more than 38000 customers – both large enterprises and small and medium enterprises – in 120 countries. SAP, a market leader in collaborative, inter-enterprise business solutions, has a rich history of innovations

Table 6.3: Details of the Interviews Conducted at SAP

#	Position/Role	Location	Date of Interview	Mode of Interview
1	Managing Director SAP Labs India	Bangalore India	November 24, 2005	Face-to-Face
2	Vice President Mobile Business Solutions	Waldorf Germany	September 28, 2005	Telephone
3	Product Architect Mobile Business	Waldorf Germany	September 28, 2005	Telephone
4	Director SAP Business Solutions	Waldorf Germany	November 24, 2005	Telephone
5	Director Mobile Business Solutions	Bangalore India	September 28, 2005	Face-to-Face
6	Development Manager Mobile Business Solutions	Bangalore India	September 28, 2005	Face-to-Face
7	Project Manager Mobile Business Solutions	Bangalore India	September 28, 2005	Face-to-Face
8	Development Manager Mobile Business Solutions	Bangalore India	September 28, 2005	Face-to-Face
9	Vice President ERP Solutions	Bangalore India	November 24, 2005	Face-to-Face
10	Development Manager & Program Head SAP Industry Solutions	Bangalore India	November 24, 2005	Face-to-Face
11	Project Manager SAP Industry Solutions	Bangalore India	November 24, 2005	Face-to-Face

and growth.[8] At the end of fiscal 2006, SAP had more than 100,600 installations worldwide, over 1500 partners, and 25 industry-specific business solutions. In 2006, SAP posted €9.4 billion in annual revenue and recorded a net income of €1.871 billion. Software accounted for 33% of SAP's revenue in 2006, whereas Maintenance and Consulting contributed 37% and 25% respectively. In terms of revenue breakdown by sales destination, 28% came from USA, 20% from Germany, 32% from EMEA (excluding Germany), 8% from the rest of Americas, 5% from Japan, and 7% from the rest of Asia Pacific.

[8] See http://www.sap.com/company/history.epx for a chronological account of SAP's fascinating history of innovations and growth.

SAP offers a comprehensive range of software-based industry solutions, business solutions, and services as well as software–based business technology platforms. SAP Industry Solutions incorporate in-depth knowledge of business processes in specific industries and are meant to provide improved visibility across the enterprise, facilitate effective decision making, and enhance efficiencies. SAP Solutions – arrange of generic enterprise software applications and solutions like enterprise resource management, supply chain management, customer relationship management, product lifecycle management, etc. – provide capabilities for business transformation, enterprise agility and business optimization. SAP Solutions also include governance, risk and compliance solution, new product development and introduction solution, and solutions for small and medium enterprises. In addition, SAP also provides composite applications for mobile business and business analytics. Finally, SAP Platforms like NetWeaver, which is based the concept of enterprise service oriented architecture, provides an IT landscape that helps organizations improve their responsiveness and flexibility in support of their changing business and competitive requirements.

SAP also provides a portfolio of consulting and professional services that span all phases of solutions lifecycle and help maximize enterprise success through a combination of SAP experts, methodologies, tools and specialized and certified partners. SAP invests significantly in research and development (see section 2.2 for details) and also operates SAP Ventures that invests in entrepreneurial ventures with the aim of catalyzing industry-leading companies.

6.2.1.1 Business Environment, Success Factors, and Strategy at SAP

SAP is an undisputed market leader in the business software category and operates amidst growing demand for its offerings globally. With global IT spends growing at 8% per annum, especially in the enterprise applications segment, SAP is well positioned to continue to leverage its strengths and expand its market dominance. Traditionally, SAP has continually added new vectors of differentiations on its flagship products to stay ahead of its competitors, and continues to demonstrate its innovative prowess. However, the competition is rapidly intensifying, and recent consolidations in the industry due to mergers and acquisitions have greatly altered the competitive landscape for SAP.

Notably, Oracle's acquisition of two of its competitors, PeopleSoft and Siebel, in 2005 has caused competitive shocks to SAP. Other large software majors such as IBM and Microsoft are also increasingly entering SAP's core markets and competing with it more directly. SAP also stands to face threats from coopetitive activities of its competitors and cooperative partnerships between them and niche, third-party players.

Also, there is a growing threat from the open source phenomenon that has the potential for introducing substitute products, affecting SAP's market dominance. Moreover, a growing cost consciousness among enterprise software buyers implies that SAP would need to find ways to market its products in a more compelling way while also achieving its profitability targets. Also, like most enterprise software vendors, SAP also has the opportunity to capitalize on the immense emerging market opportunities but this requires suitable adaptations in its product-market mix and pricing strategies for being successful. In addition, traditionally licensing to large enterprise customers has been the main revenue source for SAP, but further market penetration requires SAP to also actively pursue small and medium enterprises market segment, which is a huge market.

SAP operates amidst rapid business and technological change and, therefore, its ability to successfully deal with these changes is vital for its continued success. For example, the intensifying trend of business process outsourcing (BPO) could result in increased competition for SAP as systems integrators and IT service providers could bundle SAP offerings with their services leading to reduced sale of its products. SAP also needs to carefully craft its business strategy in the wake of the growing popularity of the utility computing paradigm. Likewise, it is equally critical for SAP to keep pace with technological change and effectively incorporate new technologies in its products and solutions in a timely manner. In addition, in order to advance its competitive objectives, it is equally critical for SAP to develop and leverage an ecosystem of partners (including IT services vendors) that implement and integrate SAP products as well as develop applications on its platforms.

In view of the changing market and competitive dynamics, it is imperative for SAP to continue to innovate and produce differentiating products, solutions, services and business models. Towards this, there seems to be a well-crafted strategy in place at SAP. In 2006, the Company introduced enhanced versions of SAP ERP as well as SAP CRM and SAP SCM solutions keeping its heritage of adding new vectors of differentiation on its products. The company has embarked on major initiatives to address market requirements for smooth integration of its products and solutions with other enterprise software products. SAP is also investing in introducing new solutions in the areas of regulatory compliance and risk management across industry segments. Also, it is building in deeper analytics capability to improve the market attractiveness of its products and solutions. In addition, to keep pace with changing customer requirements, SAP is constantly investing in acquiring wider and deeper domain capabilities.

In line with the changing technological landscape, SAP has made significant headway in developing service-oriented architecture (SOA) based platforms (e.g., NetWeaver) that facilitate smooth inter- and intra-enterprise applications and services integration as well as easy creation of new enterprise applications. The company has also invested in developing a Business Process Platform on which customers and partners can flexibly evolve business processes, business solutions and business models. As a measure to widen its global market penetration, SAP has established a strategic thrust on small and medium businesses (SMB) as well as fast growing emerging markets in BRIC nations (Brazil, Russia, India and China). Of course, both its emerging markets and SMB strategies requires SAP to suitably adapt its existing offerings, develop new offerings, and sell them at feasible price points. An effective partner ecosystem is vital for realization of SAP's strategic intent in expanding its regional presence. In fact, SAP has set aside US $125 million for stimulating a global partner ecosystem to develop next generation composite applications on its NetWeaver platform.

There are several implications for SAP's R&D as well. First of all, R&D needs to ensure effective incorporation of new technologies such as SOA in its platforms and offerings in a timely manner. Being able to deliver compelling user experience is also vital for SAP, which obviously has implications for how the products and solutions are designed. Also, given that 37% of SAP's revenue comes from software maintenance, it would be critical for SAP to organize its activities in such a way that profitability accruing from its maintenance revenue could be maximized. Finally, it would be crucial for SAP to maximize its R&D productivity given its relatively high R&D intensity.

6.2.1.2 Research and Development at SAP

SAP makes significant investment in developing cutting edge innovation. In 2006, the Company invested €1.3 billion (14% of total revenue) in research and development. Figure 6.4 shows R&D spending at SAP during 2003-2006 as a fraction of its annual revenue. SAP's global research and development network consist of SAP Research Centers and SAP Labs, which together employ 11801 employees. Currently, SAP has 11 Research Centers (including 3 in Germany) and 9 Development Labs (SAP Labs) spread across the world as depicted in Figure 6.5.

SAP Research is SAP's global technology research unit that seeks to impact SAP's competitive positioning by identifying and shaping emerging IT trends through research and corporate venturing. The activities of SAP Research have a long-term (three-five years) orientation and primarily include identifying and evaluating new technology trends, and developing concepts and prototypes for new and future SAP products. It has more than 200 employees and uses a model of co-innovation implemented through collaborative research. Its corporate venturing arm, SAP Inspire,

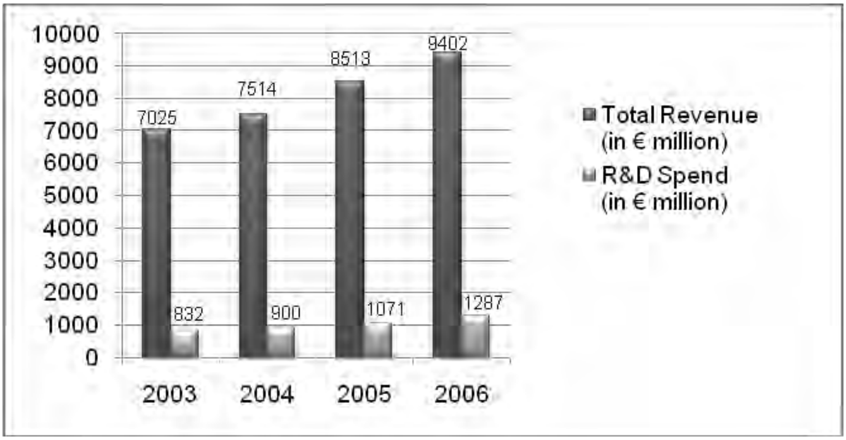
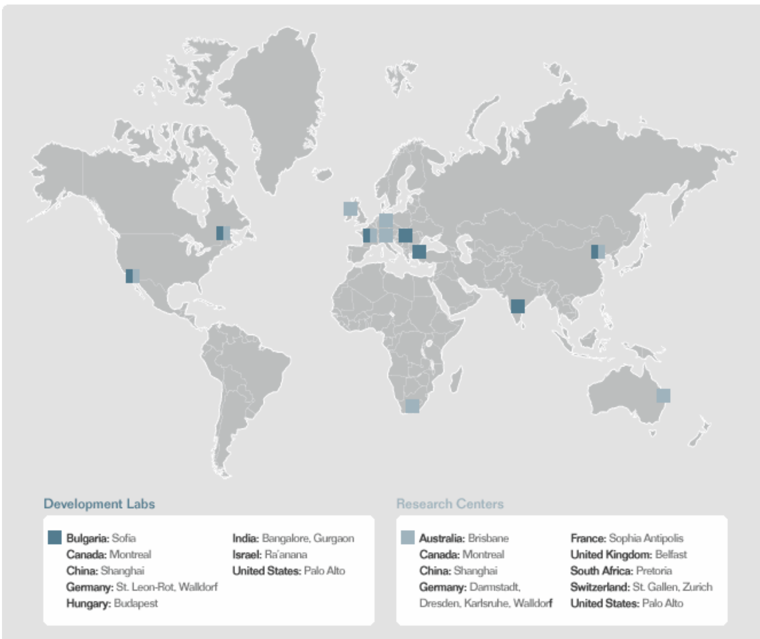


Figure 6.4: R&D Spending and Annual Revenue at SAP during 2003-2006



Source: SAP 2007 Annual Report

Figure 6.5: SAP's Global Research and Development Network

catalyzes intrapreneurship by nurturing ideas from employees, customers and partners and explores new growth opportunities to enhance SAP's portfolio of offerings.

SAP Labs have been organized to leverage distributed development paradigm and focus on accelerating innovation and improving productivity. These labs research, design, and delivers leading-edge software products and solutions for SAP. They represent a dynamics community within SAP's global research and development organization that explores and integrates new ideas and leading edge technologies to keep SAP at the forefront of business success. SAP Labs are recognized centers of local talent and expertise, and facilitate access to the local ecosystem of partners for co-innovation of new products, services and solutions.

6.2.2 Offshore R&D Engagement

SAP has had development presence in India since early 1997, when it started doing localization projects for India as well as other countries. At that time, it brought a few Indian software engineers from Singapore and established a 40 people localization group. SAP Labs was formally set-up in Bangalore, India in 1998, the same year when SAP acquired Kiefer & Veitinger, a company that specialized in sales force automation and had 80 people in Bangalore. So, the root of SAP Labs India can be traced back to a combination of localization activities and the activities of the acquired group.

Currently, SAP Labs India is the second largest research and development center for SAP. Since its inception in 1998, SAP Labs India has grown to over 3000 employees and contributes to approximately 22% of SAP's global R&D and support and services activities[9]. It performs work across its full value chain, and is engaged in collaborative software engineering, research and breakthrough innovation, product and technology development, customer solutions, global services and support, and production. It is an integral part of SAP's global R&D network and focuses on key areas like enterprise resource planning (ERP), customer relationship management (CRM), supplier relationship management (SRM), NetWeaver platform, Globalization, Industry Solutions, Active Global Support and Installed Base Maintenance.

Today, every part of the SAP stack is being done in India, even if partly. A lot of R&D related to NetWeaver platform, Master Data Management, App Xchange, and All-in-One,[10] all of which are core parts of SAP's competitive strategy and involve development of new platforms or offerings, is being done in SAP Labs India. Nearly 80% of the All-in-One initiative is concentrated in India and for this, 500 people were assembled in less than 9 months. As a matter of fact, SAP Labs Bangalore is the only

[9] These figures are as of December 2006 and are based on SAP A.G.'s 2006 Annual Report.
[10] All-in-One is an integrated solution meant for mid-size businesses.

R&D Center outside of Germany that is doing such a breadth of work. The other SAP Labs are quite focused.

According to the Company's 2006 Annual Report, over the next five years, SAP will invest US $1 billion to expand its footprint in India, enhance its operations, and utilize the talent to increase the R&D contributions of SAP Labs India. Although SAP initially established its R&D presence in India to cater to local and neighboring market needs, its rapid growth is attributable to the availability of low cost, high quality, and vast talent pool in India. Moreover, the ecosystem in India, which has a concentration of many leading independent software vendors (ISV), is of appeal to SAP as its partnership strategy rests significantly on access to such ISVs. The ecosystem also gives SAP access to skilled and experienced resources including people who have customer experience. The existence and evolution of SAP Labs India can be best summarized in the words of the Vice President of SAP's Mobile Solutions Group based in Waldorf, Germany:

> *Originally, in 1995-1996, it was tough to get good people on the market here, so we were looking for a location where there is a good quality and large resource pool. Bangalore was an obvious choice and many other companies were also there. Now, given the competitive pressure, cost has also become important. At more expensive locations, we would focus on special work, whereas Locations like India and China will expand.*

6.2.3 Organization and Management of Offshore R&D

This section presents an account of the organizational and management processes associated with SAP's offshore R&D engagement. The section begins with a discussion of the structural characteristics of the offshore R&D engagement between SAP Germany and SAP Labs India. Then, an account of the relational characteristics between the two entities is presented. Finally, a description of the R&D task allocation practices as seen in the SAP's offshore R&D engagement is provided.

6.2.3.1 Structural Characteristics

Currently, SAP Labs India operates as a cost center[11] and is not an independent subsidiary with its own product-market mandate. It works as an R&D base for SAP and engages in distributed research and development work in collaboration with other groups and SAP Labs locations. SAP's Lines of Businesses (LoB) like NetWeaver, CRM, SCM, etc. make decisions on what is needed for their products and by when. They then decide the R&D location where they would like technology and product

[11] Simply put, a cost center is a type of business operation that does not have any profit and loss responsibility.

development to take place. It seems that usually the choice of a Lab is guided by such considerations as talent pool availability, the potential for cross group leverage, cost factors, and the local ecosystem appeal. However, interviews indicate that there may be policy-enforced constraints such as hiring freeze that may apply to some centers limiting the choice of location for the lines of businesses.

The organization of SAP Labs India resembles the characteristics of a matrix structure. Once the work and location decisions are made, entities like SAP Labs India host R&D activities for the lines of businesses. In a sense, SAP Labs India provides services to the lines of businesses at different levels of complexity and sophistication as their business partners. The lines of businesses provide the requisite funding for carrying out the R&D activities. Market and customer facing functions like product management and solutions management do not reside within SAP Labs India. These are the functions that typically determine the product or solution requirements. SAP Labs India receives ideas from functions like Solutions Management and Product Management, as well as from the customer support teams and through our direct interactions with customers, to guide their R&D activities. Figure 6.6 shows the organization and governance structure for SAP Labs India.

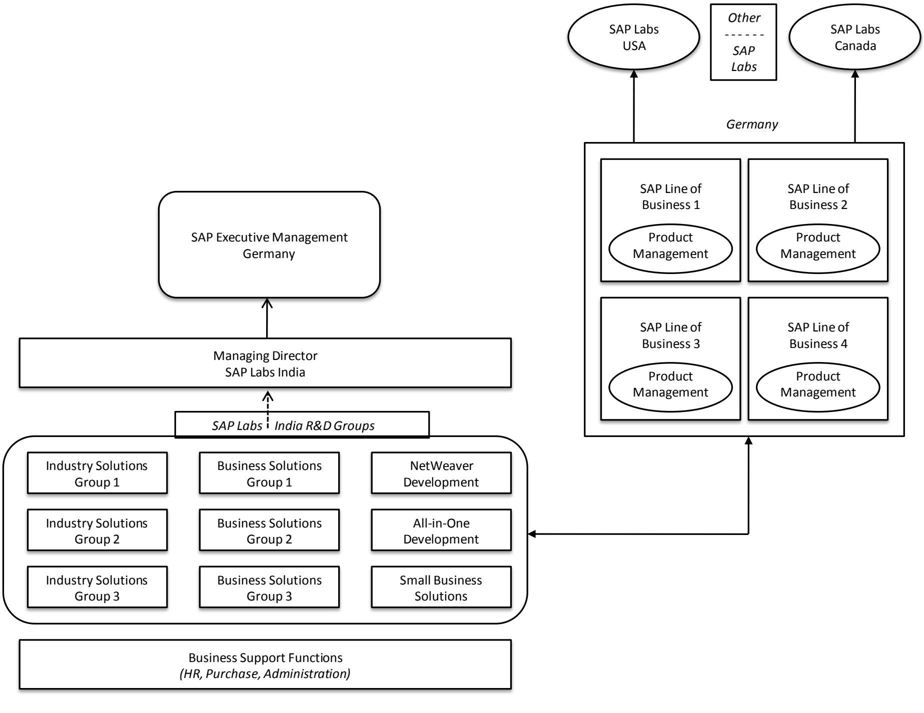


Figure 6.6: Organization and Governance of Offshore R&D at SAP

Describing the operating model that applies to the nature of work and responsibilities of SAP Labs India, its Managing Director said:

> *As hosts for their LoBs, SAP Labs India makes things easy for them. LoBs own the R&D groups and so they invest in building teams and developing long-term capabilities. India offers a highly scalable talent pool with a relatively quicker ability to ramp-up resources for R&D projects. LoBs can tap into SAP Labs India resource pool in an on-demand manner to perform custom solutions development, where people can be flexibly grouped together.*

The interviews with senior managers at SAP had frequent mentions about a corporate policy that warrants a need to harmonize across SAP Labs but given the above described operating model, which gives full autonomy to LoBs to choose their R&D location, it is not clear how this policy is effectively deployed in practice.

6.2.3.2 Relational Characteristics

SAP Labs India executes R&D responsibilities allocated to it by the Lines of Businesses (LoBs). However, interviews indicate that often the R&D for a line of business is distributed across different SAP Labs locations. This means that SAP Labs India has to collaborate with the other SAP Labs organizations in performing its work. SAP Germany, where almost all of the lines of businesses are located, serves as the nodal organization and coordinates R&D work across locations.

It appears that most of the lines of businesses prefer to locate a bulk of their R&D activities in India because of low cost structures and the ability to quickly ramp-up R&D teams. This is especially true for the back-end R&D activities that do not require proximity to markets or customer interactions. It also appears that from time to time the other SAP Labs locations are imposed restrictions such as hiring freeze, preventing them from recruiting additional staff whereas high growth locations like India and China do have some flexibility. However, the other locations like USA and Canada have existed longer than SAP Labs India Bangalore, thereby having deeper knowledge of SAP products, solutions and customers' business processes.

The combination of unrestricted growth on one hand and the capability differential on the other hand is a source of tension in SAP Labs India's relationship with other SAP Labs location as well as with the Headquarters in Germany. For example, Mobile Business Solutions R&D, which is spread across Germany, Canada, Japan and India, has its own relationship dynamic, as is indicated by the following comments of a Development Manager of Mobile Business Solutions at SAP Labs India.

> *Bangalore and Montreal have one thing in common – applications. Because of that, of course, there will be a few tiffs here and there. People want to prove each other. There is also a tendency to hide information. Currently, a lot of work is moving to India.*

Another group, which now owns the R&D for Apparel & Footwear Industry Solution at SAP Labs India, has come a long way from being an extended R&D team for Germany to owing the full solution responsibility. The Program Head for the Solution said that the SAP Labs India team wanted to be independent and minimize the knowledge and expertise dependency on their German colleagues. He candidly offered a glimpse of the existing dynamics in the relationship while narrating the evolution of his group:

> *They think they are losing their jobs to India, to lesser capable people. I get a message from a customer saying that here is a problem; please pass this on to your German colleagues to solve. It is an insult to me. My team said we would like to change this within a year, and I would say we have achieved it. We now own customer problems and relationships.*

Embedded in the relationship are implicit traces of internal competition between various SAP Labs locations as is suggested by the following comments of the Vice President of Industry Solutions at SAP Labs India:

> *My team realizes that we got the work because of low cost but the team wants to prove their intellect, their capability that we are at least as good as elsewhere. We have an urge to prove them wrong.*

Interviews with informants in the Mobile Business Solutions group also confirm a similar dynamic in relationship, where R&D work has moved from other SAP Labs locations to India. The people at the handing over location experience stress owing to a possible threat of jobs, so a personal hook-up is extremely necessary, said many informants. In the absence of a personal and productive relationship, according to the informants, people don't really share knowledge. And, sometimes, said a Project Manager, *"They actually want you to fail, just to prove a point."* Commenting on information flow, a Development Manager of the Mobile Business Solutions Group at SAP Labs India observed:

> *I think the information flow is adequate, although occasionally there are issues. Sometimes the emails are in German, and time zones and language differences are also an issue, especially with Tokyo and Montreal.*

People frequently travel to other locations for work, which also results in relationship building and strengthening of social ties between people and locations. Knowledge sharing is good. And, by and large it appears that the tension in the relationship is not all that intense and that people from across various locations actually cooperate well. This is perhaps due to the expanding pie of business that SAP is currently enjoying, which ensures that there is enough work for every R&D location and no major threat of jobs for people. Of course, a globally distributed R&D network means cultural diversity that SAP encounters. In the words of the Director of the Mobile Business Solutions Group at SAP Labs India:

> *People at different locations not only come from different cultures but they also build software differently. In fact, the mental make-ups are different, the belief systems are different. Indians are eternal optimist. In fact, nothing seems to be impossible for us in terms of timelines. I think this is where we have to improve. Combine this with a typical German reluctance to commit to things that don't look safe, or a Canadian skepticism on whether someone can do things, and you find a good dynamics at play here. Your enthusiasm is tempered by some. That helps to iron out project risks.*

However, there seems to be no explicit strategy in place at SAP that systematically leverages the cultural diversity, and yet this cultural diversity silently manifests in significant advantage for SAP, as is discussed later.

6.2.3.3 R&D Task Allocation

In order to study the engagement model and patterns of work allocation, I examined in depth two programs in SAP's offshore R&D engagement: Mobile Business Solutions and Apparel & Footwear Industry Solution. Both of these programs are among the large programs at SAP Labs India and have evolved over a period of time with growing levels of ownership.

SAP Mobile Business Solutions is a suite of applications that provide access to information and processes anytime, anywhere, and on a variety of mobile devices. SAP Solutions for Mobile Business includes SAP Mobile Sales, which enables sales order management, account management, activity and task management, opportunities management, product catalog management, and product survey. SAP Mobile Sales is available for handheld computers and smart phones as well as for laptop computers and is designed for use with mySAP CRM. There is also a specific handheld version of SAP Mobile Sales for the pharmaceutical industry. The SAP Solutions for Mobile Business Suite also includes SAP Mobile Service, which lets service workers view and confirm every step of remote service management processes. SAP Mobile Service provides a broad range of mobile service functionality, including: service management, service order management, service confirmation, account management, task and activity management, absence and attendance management, and complaints management.

The SAP Solutions for Mobile Business suite also includes SAP Mobile Asset Management, which empowers mobile workers to perform their daily activities related to plant maintenance and customer service in the field -- at customer sites and within plants -- while disconnected from the back-end SAP system. The application delivers an extension of asset life-cycle management features and functions that are provided in mySAP Product Lifecycle Management. Using SAP Mobile Asset Management engineers and technicians in the field can handle order management, inventory management, notification management, measurements and counter readings, business partner management, and technical object management. SAP Mobile Asset Management is available in either a standard version or an industry version tailored for utility companies. The application is designed for a handheld device but runs on both handheld and laptops computers.

SAP for Consumer Products enables companies in the Apparel and Footwear industry to perform their most critical business processes, including new product development and introduction, demand and supply planning, order to cash management, sales force management, and management of inbound and outbound logistics. The solution enables an integrated, closed-loop new product development and introduction (NPDI) process, spanning project management, resource and time management, idea and concept management, collection design and product development, prototyping and ramp-up, document management, quality engineering, and market launch. With support for collaborative product development, the solution simplifies the integration of key activities such as project management, document management, and product design across locations or with external partners. It also enables comprehensive product data management, helping manage large volumes of data, including styles with color and size variations, country-dependent dimensions, size scales, and quality grades as well as season and collection assignments. The solution provides multiple advanced capabilities through integration to other SAP solutions like ERP, CRM and SCM.

At a high level, there seems to be some understanding within SAP as to how different SAP Labs will be leveraged to create an innovation network for SAP. According to the Managing Director of SAP Labs India:

> *A lot of our R&D gets done in a distributed way. Our philosophy is to have networks of labs with focus, ownership, responsibility, and leadership. We don't believe in the extended workbench model*

> *wherein Germany would be the center of the solar system and everything revolves around that.*

However, things on the ground at SAP Labs are different! Currently, ownership is only at the project level; there is no real product level ownership yet except in a couple of areas. Most of the activities follow a co-development model, where the teams from SAP Labs India participate in product and solutions development programs along with other locations or have ownership for support and maintenance of previous versions of the products. The Managing Director of SAP Labs India acknowledges the current reality:

> *Even though people agree with the philosophy, it takes time. Our products require a lot of learning; you can't just transfer responsibility. We are in the process of transitioning into this model.*

Consider the case of the Mobile Business Solutions R&D program at SAP Labs India, which has been running for seven years now but only lately it has metamorphosed from being a mere execution engine to an ownership-based contributor. The SAP Solutions for Mobile Business are available on both laptop and personal digital assistants (PDA). The Mobile Business Solutions activities are organized in Montreal (Canada), Tokyo (Japan) and Bangalore (India), whereas business development, solution management and development architecture related activities are concentrated in Waldorf (Germany). Currently, SAP Labs India has a 65 people team working on various aspects of SAP Mobile Solutions R&D, which has grown from a small size of 10 people in 2003.

The work allocation philosophy for Mobile Business Solutions (MBS) seeks to avoid location interdependence. MBS work can be mainly divided in two parts: server side work and client side work, and this division is used for allocation of work. Also, MBS has a class of applications and each location has its own set of responsibilities. MBS in Bangalore does new product development for mobile sales force automation. Because of cost reasons, a lot of maintenance and support activities are also happening out of Bangalore. The other two locations have proximity to customers and markets and primarily do new development. Bangalore has traditionally been quite strong in CRM, so all the work related to mobile CRM domain now comes here. Also, the other SAP CRM development teams are located in Bangalore, so the MBS R&D teams can interact with them, exchange knowledge and exploit synergies. The PDA versions of the solutions use J2EE technology, whereas laptop based mobile solutions are on .NET platform. All the .NET based laptop solutions are developed fully in Bangalore, whereas the J2EE based PDA solutions are done at all the three locations. Germany serves as the nodal point.

Before its transition to ownership-based responsibility, the SAP Labs India MBS team basically worked as an extended arm of SAP Germany, which was responsible for design and development of applications besides handling customer interactions. The India team was responsible for the development of a few components. However, in 2004, in anticipation of Microsoft's plan to phase out support for Visual Basic, the SAP Labs India team was given the charge for migration of SAP mobile solutions to Microsoft's new .NET platform, which was largely driven by SAP Labs India. This was also in line with SAP's intended location policy as part of which all development for an application is consolidated in a single location Eventually, SAP Labs India came to own all the .NET based laptop solutions for mobile business. Later, SAP Labs India team also developed a PDA companion solution as part of SAP mobile applications suite. Traditionally, these applications were available only on laptop.

SAP Mobile Business Solutions also include Mobile Asset Management (MAM), which works with SAP Enterprise Asset Management. MAM is the biggest application in the mobile business suit. Mobile Asset Management was originally developed at SAP Labs Canada in Montreal that has now been tasked with the responsibility for developing MAM Version 3.0. The MAM Versions 2.0 and 2.5 were moved to Bangalore for enhancements and support. The MAM Version 2.5, which has an additional RFID feature over MAM Version 2.0, caters to the current markets whereas the Version 3.0 is aimed at opening new market opportunities. In fulfilling its responsibilities, the MAM team in Bangalore interacts with other SAP locations for new requirements, bug fixes and handling customer escalations. Since the time MAM Version 2.0 was moved to Bangalore, the SAP Labs India team has improved its performance, reduced time to customer support, and built relationships with customers. They have analyzed the bugs and fine-tuned the code for better performance. The SAP Labs India team anticipates that the MAM Version 4.0, which will involve developing composite applications – SAP's new strategic thrust area I line with its Enterprise Service Architecture (ESA) initiative – will be done in Bangalore. In fact, the team in Bangalore is already doing some preliminary work on MAM 4.0, planning composites and components.

The SAP Mobile Business Solutions Group faces continuous change in technologies and in order to continue to be market relevant, it has to keep pace with constant technological changes. This means that the SAP Labs R&D teams have to adopt the SAP Mobile Business Solutions accordingly and in a timely manner. For example, the SAP Labs India team has to adopt the laptop and PDA based solutions they own for tablet PC, pocket PCs and other new handheld devices, and this means that they continually face new requirements. Commenting on the abilities of SAP Labs India and the significance and nature of its contributions, the Director for Mobile Business Solutions in India observed:

> *Our biggest strength is technology. Next is product knowledge. Now, we are beginning to understand markets and customer nuances. We now do things that help us avoid customer escalations. We are fast learners and have skills in new technology. But we are focused on too many things, so there is a depth issue. The flexibility to move to new technology is part of the culture here.*

Over a period of time, the SAP Labs India team has become an integral part of SAP's Mobile Business Solutions Strategy. Its nature of contributions has also evolved from being merely an extended team responsible for implementation to a technologically proficient resource pool participating in the planning process. However, the distance from markets and customers is a constraint for enhancing the impact of SAP Labs India as is indicated by the following statements of a Development Manager of the Mobile Business Solutions Group at Bangalore:

> *Our involvement is high right from the planning phase, but our influence is less. This is because our major markets and customers are in the U.S. and Europe, and our overall experience is also an issue.*

From interviews with people from SAP Mobile Business Solutions it appears that usually SAP Labs Bangalore is entrusted work for product enhancement, maintenance and customer support – activities that pertain to the late stages of the product lifecycle or involve customization of solutions for specific customers. This way, SAP is able to free-up experienced and expensive resources at other locations for strategic R&D projects, and leverage the low-cost expertise in India to reduce product TCO and improve its profitability. It also appears that when emergence of a new technology or platform (e.g. .NET) requires migration of its products, SAP finds it appealing to locate such work in SAP Labs India.

From the preceding discussion it seems that SAP follows a deliberate strategy to decouple its offshore R&D Center – SAP Labs India – from work that requires extensive customer interactions or proximity to markets. Instead, it leverages the vast, technologically proficient resource base of SAP Labs India for development and improvement of its products and solutions. Clearly, risk management is also a key consideration as the evidence in the preceding paragraphs provides a hint for an approach to work allocation that accounts for lack of cumulative experience at SAP Labs India.

Informants from the Apparel and Footwear Industry Solutions (AFS) R&D group reveal a similar pattern of work allocation. AFS is an industry solutions built on top of SAP ERP application base, which achieved revenue of US $29 million in 2005. AFS initially started as custom development in Munich and later, in recognition of a sizable market opportunity, became a formal industry solution. The SAP Labs India team got involved with AFS as a small extended team providing support and doing special development work. Initially, the team in India would do support and maintenance whereas the team in Munich was responsible for new development. Component ownership was gradually transferred to Bangalore and in September 2004, the entire R&D responsibility for AFS was moved to SAP Labs India. The R&D team in Munich was released of AFS responsibility and given new work for development of other industry solutions.

SAP Labs India now owns the Apparel and Footwear Industry Solution and has end-to-end R&D responsibility, including planning and roadmapping, for the solution. After taking over, the India team added around 30% more features (15 additional features) and released the AFS Version 2.0. The team brings out new releases to the market every two years according to a defined roadmap, and participates in user and customer conferences and innovates based on market requirements besides doing custom development for clients. However, Solution Management continues to be based in Germany. SAP Labs India AFS team is not the face for customers but interacts with them.

"Developing industry solutions requires deep knowledge of the domain and business processes. The problem is that in India we don't find people with functional or industry background, and that affects our work," said the Vice President of Industry Solutions at SAP Labs Bangalore. This is perhaps why the solution management function has not been moved to Bangalore. Also, the available information on AFS roadmap and release schedule suggests that perhaps this is not a solution that undergoes significant changes frequently, and so locating the R&D work for this solution in Bangalore does not pose any major risk for SAP. Instead, given the relatively small revenue this solution earns, a low cost location like Bangalore can help squeeze more profitability for SAP.

However, interviews with executives in SAP Germany reveal that employee turnover in SAP Labs India is also an issue that prevents re-location of critical responsibilities to Bangalore. One Mobile Business Solutions Development Architect based in Waldorf, Germany, with whom I spoke at length, commented:

> *When we think of transferring work, we are always skeptical whether the people will stay.*

Another Director from SAP Industry Solutions, Germany remarked:

> *Attrition is a major problem. On one hand knowledge is being gradually transferred to Bangalore and on the other hand people leaving results in loss of knowledge.*

6.2.4 Offshoring of R&D and SAP's Innovative Capability

This section presents findings related to (a) generation of innovation by SAP Labs India and (b) transfer of knowledge from SAP Labs India to SAP A.G.'s corporate headquarters in Germany.

6.2.4.1 Innovation Generation by SAP Labs Bangalore

For SAP, product innovation is a competitive necessity but being able to impact business process innovation is crucial for its marketplace performance. However, delivering business process innovation requires deep industry knowledge and proficiency in vertical specific business processes. Business process innovation also requires proximity to customers and markets, something the SAP Labs India team does not enjoy since SAP's major customer base is in the U.S. and Europe. Often, the customer needs are the sources of ideas for innovation. So, it is natural that there will not be many instances of business process innovations at SAP Labs India. The interview findings readily testify this. Commenting on innovations from SAP Labs India, the Vice President of SAP Mobile Business Solutions based in Waldorf, Germany said:

> *Innovations came later – it took time. SAP focuses on business process related innovations, not really technology. And it takes time to understand the business process related aspects and innovate there. But, definitely innovations have come from SAP Labs Bangalore like business process innovations in high tech and automobile areas. For example, a dealer management solution was developed by SAP Labs India as part of our automotive industry solution portfolio. Likewise, a completely new mobile application for sales and services was created from India.*
>
> *What you need is people sitting in the market who can work with R&D. Any innovation would not have been possible if it would be attempted to be done purely from India. You need to have access to customers and maintain close communications with them.*

Indeed, there are instances of innovations from SAP Labs Bangalore but they are primarily either technological or incremental product innovations. Take the SAP Mobile Sales solution for example for which SAP Labs India created a pharmaceutical industry specific variant with unique capabilities. The Development Manager for

Mobile Business Solutions R&D group at SAP Labs India elegantly described the solutions features and associated innovations:

> *When a medical representative goes to a doctor, he has finite time and in the U.S. he has to fulfill some legal requirements like handing over only a certain number of samples and obtaining doctor's signature. The entire process had to be completed within 30 seconds because beyond that you don't get time with the doctors. So, on SAP's mobile sales solution, we created a pharma industry variant that does Java based signature capture on a PDA. This was a new technology innovation and has subsequently been patented. There were numerous Microsoft technology based solutions, so we created a Java based secure online signature capture through PDA.*

SAP Labs India team also built an "available-to-promise check" on SAP's Mobile Sales solutions before a salesperson takes the sales order form using a PDA device. They claim that this too is unique in the market. Explaining the significance of this innovation, the Mobile Business Solutions Development Manager at SAP Labs India said:

> *Typically, sales representative would download data from the SAP CRM server. It was an expensive solution for some segments like pharmaceuticals. Using the same technology framework, we developed a PDA based solution. This initiative was taken in India. We developed a prototype and had the VP for SAP Mobile Business Solutions approve the integration of the PDA companion with the solution suite. The idea, of course, came from the market. This was something we worked on beyond office hours.*

Usually, ideas or requirements for innovations come from customers. For example, the Java based PDA signature capture idea did not really originate within SAP Labs India but instead it was forced upon them since Solution Management had already promised it to SAP customers. The sources of innovation ideas notwithstanding, the work being done at SAP Labs India is technically complex. For example, running an application on a PDA device poses its own challenges like addressing issues of scalability, user interface, performance, and data handling related constraints. Moreover, due to continuous changes in technology, the R&D teams have to adapt their solutions accordingly.

According to the Director of the SAP Mobile Business Solutions R&D Group at SAP Labs India, 10% of effort is dedicated to intellectual property creation and product innovation. Nearly 90% of Mobile Business Solutions related patents applications were filed by SAP Labs India, which I gathered, included a good number of usability related patents. SAP Labs India has also contributed to incremental innovations by incorporating such features as SMS based Mobile Push Alert add-on to SAP's Mobile Asset Management Solution.

There are occasional examples of process innovations that have been introduced by SAP Labs India on SAP's base ERP. For instance, in the high tech industry, management of channel partners is different than other industries involving several processes. SAP Labs India has addressed these challenges by incorporating processes like price protection that have improved the solutions appeal among its customers. Also, for the Apparel and Footwear Solution, SAP Labs India has built new processes like stock allocation process. Allocator Run – the component that added the stock allocation process capabilities on AFS – was conceptualized and developed in SAP Labs India and turned out to be a competitive differentiator for the solution. Also, the AFS MRP run including all its features and enhancements were done out of India. AFS has interfaces with other SAP components like CRM and SCM, business warehouse system, etc. The connectivity to the other SAP solutions like CRM and SCM is rather complex and such integration was largely done by SAP Labs India.

However, by and large, SAP Labs India has contributed incremental revenue growth by doing custom solutions resulting in customer base expansion, reducing the total cost of ownership (TCO), and ensuring backward-forward compatibility. And, even though ideas for innovation usually come from customers, how well and efficiently they are implemented matters. Currently, this is where the innovation efforts of SAP Labs India seem to be primarily concentrated.

SAP Labs India has contributed to SAP's products by adding new features, improving user interfaces, or by stabilizing products and improving their performance through implementation innovation, which has resulted in reduced time to customer support. SAP Labs India also generated roughly 10% of total invention disclosures in SAP during 2004-2005. SAP Labs Bangalore has an idea management system but so far there has not been any idea with any visible or measurable impact for SAP. According to its Managing Director, one of the main strengths of SAP Labs Bangalore is its technically proficient and young talent pool. He opined:

> *It helps inject a start-up spirit because of young talent pool having agile and flexible mindset. That was one of the motivations a few years ago to go out of Germany and leverage the diversity of other locations. Of course, cost is a factor, although it was never the driver really but it helps to have this advantage.*

Yet, despite its seven years of existence, breadth of work, and large resource base, the volume of innovation, whether product or process related, is somewhat abysmal. SAP managers based in Germany concur with this assessment, as each one of them that I spoke to was stretched when I asked for examples of innovations from SAP Labs Bangalore. Their common response was: "Can't think of any innovation in particular except improvements in features or better handling." A Director of Industry Solutions in SAP Germany observed:

> *India team is technically very good, but no major innovations yet. Mostly ideas for product or solution improvement or product performance improvement. People in India don't have sufficient understanding of customers, markets, or industry. No big, concept level innovation from Bangalore yet. It also depends on how projects are set-up.*

Upon probing, a Development Architect responsible for SAP Mobile Solutions based in Waldorf, Germany, offered an explanation:

> *I guess the reason for lack of innovation from SAP Labs Bangalore is really the way how the India teams are participating. They are getting a lot of installed base jobs. New applications development happens in Canada and Tokyo. I think from such situations it is really difficult to innovate. Even for improvement in products, all new ideas have to fit with the installed base of products. So, the team in India is really not free to innovate.*

The same Development Architect further added:

> *Currently, the team in India is not able to contribute much. It's a young team and maybe, with more experience they can contribute more. Experience is not something you can buy.*

However, while the distance from customers and markets is understandable, and the necessary depth and experience could only be accumulated over a period of time, it appears that perhaps the manner in which SAP Labs India is positioned and approached serves as a prohibitive factor for it to be able to innovate. Consider, for example, the remarks made by one of the SAP Directors responsible for industry solutions based in Germany:

> *Complete project ownership can be moved to teams in India. People concentrate on development and do things that we need to deliver to*

> *customers. The technical know-how in Bangalore is good. Also, in Bangalore, people can be moved from project to project.*

Interviews indicate that there is an implicit preference for leveraging the flexibility and time zone advantages that SAP Labs India offers by way of its committed technical talent reservoir than harness its innovative capability for generating innovations for SAP. This is also reflected in work allocation pattern for SAP Labs India.

6.2.4.2 Knowledge Transfer from SAP Labs Bangalore to SAP Headquarters

Given that SAP Labs India is the company's second largest R&D base with 3000 people, it is conceivable that a lot of learning and knowledge creation takes place here. Moreover, since SAP Labs India performs R&D work for almost all the SAP lines of business, cross group synergy also potentially exists in Bangalore. In view of this, it is natural to expect SAP Labs India to be a strategic source of learning and knowledge creation for SAP, and the knowledge integration to be a strategic priority. However, the interview findings do not quite suggest so! Although all the people I interviewed readily acknowledged that the information flow across locations was good, it was primarily for coordination purposes.

Learning and knowledge sharing happens through WebEx sessions and through face-to-face interactions when people travel to other locations. Formal program reviews are also a source of learning and knowledge exchange. Codified knowledge in the forms of invention disclosures and documentation of customer complaints resolutions are formal ways of knowledge capture and sharing seen as knowledge integration mechanisms in case of SAP's offshore R&D operation. Of course, blogs and Intranet are extensively used for information and knowledge exchange. Also, as part of the SAP Global Mobility Program, people move from Bangalore to the other locations that facilitates learning and knowledge circulation. Many teams also exchange design tools and best practices.

Learning and knowledge sharing currently seems to be happening predominantly only in one direction – from Germany to India. There is no reverse integration of learning and knowledge from SAP Labs India to other SAP locations, including Germany. Commenting on this, the Vice President for Mobile Business Solutions in SAP Germany said:

> *There is very good communication among people across locations. However, the core knowledge is in Germany; we have people with 30 years experience. Also, we work closely with front end people. All of our developers spend time at customer sites. Teams in India are quite young, so learning and knowledge flow is usually from outside to them.*

Part of the issue surely has to do with relatively less experience at SAP Labs India when compared to other established SAP locations such as Canada, USA and Germany. Also, the employee attrition in India adds to the challenge of knowledge retention, let alone integration, as one Waldorf, Germany based Director of the Industry Solutions Group noted:

> *Attrition is a major problem. On one hand knowledge is being gradually transferred to Bangalore and on the other hand people leaving results in loss of knowledge.*

Within SAP, the knowledge is distributed across locations and is often duplicated. Take, for example, the case of Mobile Business Solutions R&D, which is distributed across Germany, Canada, Japan and India. The necessary technical know-how exists at all of these locations, which also allows SAP to deploy its Mobile Business Solutions R&D resources quite flexibly. Such flexibility warrants that knowledge and know-how be duplicated across locations, eliminating an explicit need for learning and knowledge integration. Also, SAP's policy for work allocation across locations, which seeks to reduce interdependence, limits the scope and need for interactions and thereby affects learning and knowledge integration. Yet, SAP Labs India works on new technologies and platforms and knowledge about these may be vital for other SAP locations. However, in the absence of a strategic thrust on tapping in SAP Labs India as a source of learning and proper mechanisms for knowledge integration could compromise the overall innovative capability of SAP in the long run and result in a sub-optimal return on R&D investments. Also, a lack of attitude among the counterparts to learn from SAP Labs India is indicated, which further complicates the scene. It appears that a systematic, corporate-wide initiative is essential to capitalize on learning and knowledge generation from SAP Labs India, and this may involve a combination for formal mechanisms and forums as well as facilitating socialization and building social ties.

6.2.5 Offshoring of R&D and SAP's Organizational Flexibility

In this section, based on interview findings, I discuss how SAP Labs India contributes to SAP's competitive need for flexibility. Flexibility is very important for SAP as is evident from the following remarks of the Vice President for Mobile Business Solutions in SAP Germany:

> *Flexibility is very important because business is changing every day, new technology is arriving on the scene, and our strategies are evolving. We need to be able to adapt ourselves to all these changes.*

For SAP, in addition to addressing the challenges arising due to technological, market and competitive changes, the ability to deliver customized solutions to its clients is also of equal importance. However, this implies the need for resources that can be tapped on-demand to deliver on the emergent priorities. Conversations with the informants suggest that SAP Labs India has been designed to contribute to SAP's need for flexibility at many levels. But, investigations reveal that primarily SAP Labs India offers considerable operational flexibility to SAP. Explaining how SAP Labs India addresses the company's need for flexibility, its Managing Director said:

> *Different locations instill agility and flexibility because they challenge mindset and question status quo. For a homogenous group, it is not possible. A diverse group has multiple opinions. How you are organized also determines flexibility. For example, at SAP Labs India, we have created and nurtured a large talent pool. Now, you can use them in different ways. Both the static and flexible pool structure has its advantages and disadvantages, but a good combination of both is what really works. It allows for a flexible organizational design and rapid response to business priorities.*

Sharing his views on the importance of flexibility for SAP and how SAP Labs India contributes to the company on this front, the Director for Mobile Business Solutions in SAP Labs India shared similar perspectives:

> *Flexibility is important for SAP. We are fighting multiple battles in the market, getting pulled in different directions. We can ramp-up resources quickly to respond to the emerging priorities.*

People in Germany readily acknowledge that SAP Labs India supports rapid growth and that they can start new activities by quickly ramping up teams in Bangalore. The managers in Germany whom I interviewed also acknowledge that people in SAP Labs India are fast learners and adapt to new technologies quite rapidly. This ability to quickly learn and acquire proficiency in new technologies gives SAP flexibility to incorporate new technologies in its products and solutions in a timely manner. The labor market in India is also less stringent when compared to Germany, where typically employment contracts require a six-month notice period when compared to a maximum of three months in India. This obviously makes hiring of resources in India easier and quicker.

However, managers in Germany believe that SAP Labs India enables flexibility for SAP in many other ways. According to them, the resource pool in India is young, eager to learn, has a sense of ownership, and demonstrate speed in learning and executing work. People in SAP Labs in India are also flexible with timings and are willing to stretch themselves in order to meet project objectives. Informants point to another advantage of SAP Labs India – its absence of a heritage. Many informants were of the opinion that people in Germany who have worked long on something cannot think or do things differently. They also often show resistance to change or in moving to a new technology. Whereas the young resource pool in India does not have any 'heritage effect' and can bring fresh perspectives and quickly grasp and adopt new technologies. So, it appears that besides operational flexibility SAP Labs India also offers cultural and cognitive flexibility to SAP. Following remarks of several senior managers in SAP Germany testify these traits of SAP Labs India:

> *India has a distinct advantage… It is good to have people who can adopt fast to new technologies. In other locations this might be an issue – people may want to just continue doing what they do. Also, teams in India are highly committed to their work and demonstrate a sense of ownership. They are flexible in terms of work hours. –* Development Architect, Mobile Business Solutions, SAP Germany

> *People in India are eager to learn and pick-up new things, extremely passionate and committed. They are also flexible and such a culture helps overcome the hindrances of distributed development.* – Vice President, Mobile Business Solutions, SAP Germany

> *People in other locations are conservative. They like sticking to their preferences, whereas the team in India is eager and available to do new things and thus can take care of a lot of requirements. –* Director, Industry Solutions, SAP Germany

The time zone difference is another source of flexibility for SAP, as it enables the company to do round-the-clock development and provide global customer support. Because of this, not only product development cycles are shortened but also response to critical customer escalations can be speeded up. Consider the following example shared by the Director of Mobile Business Solutions at SAP Labs India:

> *Time zone difference gives us flexibility and we are able to pack more functionality in a given time. We have also used time zone differences to our advantage to provide around the clock attention for customer support. There was a customer in Mexico that needed critical support. So, I located a few people in Montreal and leveraged the team in Bangalore to provide 24X7 support.*

The interviews also indicate that SAP Labs India provides structural flexibility to SAP. When R&D work related to end-stage of product life cycle is moved to Bangalore, resources at other locations are freed-up to take charge of other priorities. Also, interview findings suggest that whenever SAP wants to enter a new market or respond to emergent customer priorities, it taps into the large technical resource pool that SAP Labs has. For example, a significant part of SAP's mid-market solution is being developed in India. Finally, the structural flexibility is also enacted through SAP Labs India's access to the local ecosystem of independent software services vendors and partners with proven and complementary capabilities, although examples of this currently are far and few.

According to SAP Labs India Managing Director, the ability to quickly hire high quality talent pool in large numbers helps the development and growth strategy of SAP. India also has a rapidly growing market and a strong ecosystem of partners, and all these factors combined together enable SAP Labs India to contribute to the company's need for flexibility and make it a strategic base for SAP.

6.2.6 Impressions from SAP's Offshore R&D Engagement

Ever since its establishment in 1998, SAP Labs India has grown to become an integral and important part of SAP. With significant resource concentration and a wide array of R&D activities, SAP Labs India is undoubtedly a valuable entity for SAP and its prominence is only likely to grow as the emerging market opportunities in India and neighboring countries unfold. Currently, however, SAP Labs India is largely an offshore execution engine for SAP, even though in some areas it is increasingly assuming ownership for products and solutions. Almost all SAP lines of businesses have their R&D groups in Bangalore. When asked about significant contributions made by SAP Labs Bangalore, the Vice President of SAP Mobile Business Solutions remarked:

> *It is difficult to identify the significant contributions of SAP Labs Bangalore, but the value of the organization has increased from zero to huge. R&D work there is integrated with SAP Development at large. To start with, we started on a trial basis and it would not have survived if it did not show value. It does quite a lot of development work; it is not an add-on. But, it is not focused on a few areas. It started with a few teams but rapidly expanded to address a wider footprint of R&D activities. Today, SAP Labs Bangalore is working on core products and solutions like NetWeaver, CRM, ERP, etc. as well as industry solutions like Oil & Gas, Banking, High-Tech, etc. It is a fully integrated part of SAP today.*

Yet, it seems that SAP Labs India's main strength is its high quality resource pool and the flexibility it provides to SAP in addressing its business priorities. Despite its wide array of activities and large resource base, it does not yet appear to be a significant source for innovation and learning for SAP. In other words, SAP Labs India augments SAP's innovative capabilities but it has not yet contributed any major innovations for the company. Incidentally, this assessment coincides with the opinion the Vice President of Industry Solutions at SAP Labs India holds:

> *In my opinion, SAP is not leveraging enough of the India pool. They are thinking in a very short sighted way. If you want real leverage, you have to push the organization in a certain direction, you have to have a strategic aim, beyond cost and resource pool advantage, and maintain focus with that aim in mind. I don't see that aim; it is still very much line of business driven.*

Currently, SAP is leveraging its India Labs mainly to support the products that are in the end stage of their lifecycle as well as to address emergent market priorities. SAP Labs India is also engaged in development of new products but mainly as an implementer. Utilizing the innovation capacity available in India, SAP is able to carry out a wide spectrum of innovative activities, improve product TCO, achieve better profitability made possible through low cost structure in India, and also leverage its expert and experienced resources at other locations for more strategic projects. Part of the issue seems to be how the India R&D center is perceived within SAP as well as relatively less collective experience when compared to the other, more established SAP Labs locations. The distance from the market is also currently a constraint but a major part of the problem has to do with how the work is allocated to SAP Labs India. A juxtaposition of prevalent perception and type of work allocation really decides the innovation scope for SAP Labs India. However, there clearly is an opportunity for SAP to harness the intellectual capacity in India to augment its innovative capability. That will require a deliberate strategy for SAP Labs India and involve changes in engagement model and work allocation practices. This change can only be orchestrated by the sponsor of SAP Labs India.

6.3 CASE STUDY III: UNIVERSAL HEALTHCARE SYSTEMS

This case study is about offshoring of R&D by Universal Healthcare Systems, a leading medical diagnostic systems company, to its software R&D competence center in India.

6.3.1 Background and Context

Universal Healthcare Systems (UHS) is part of a multi-divisional, global industrial conglomerate with headquarters in Europe and the U.S. UHS is a leading player in the medical diagnostic imaging and patient care systems, and has a long history of innovations with a portfolio of several thousand patents. UHS develops and sells advanced diagnostic imaging system products such as X-Ray, Ultrasound, computerized tomography (CT) and magnetic resonance (MR) systems besides a range of cardiac care technologies, patient monitoring systems, and healthcare informatics systems.

With an employee base of more than 25000 people, UHS has sales presence in most parts of the world and several R&D centers in the U.S., Europe, and in the Asia-Pacific region. In 2006, UHS achieved annual revenue in excess of €5 billion and spent nearly €500 million in research and development (R&D). As a matter of fact, over the last three fiscal years, the R&D intensity at UHS has grown.

The worldwide market for healthcare systems and solutions is steadily growing on account of a growing and longer-living world population, the availability of new technologies for earlier and better diagnoses, and the increasing availability of noninvasive procedures. The growth in market is also due to healthcare reforms in many countries and the emergence of new market opportunities in developing nations. Therefore, continuous and cost-effective innovations with efficient after sales support and services is a competitive necessity for companies like UHS. Ensuring interoperability of products with other healthcare systems and products is also vital for UHS's marketplace acceptance.

The healthcare systems market has its own unique characteristics. First, besides the need for high quality and reliability, all products must comply with various regulatory requirements and be certified. Second, the medical systems field is evolutionary in nature than revolutionary. Typically, the life span of a deployed medical systems product in the field is upwards of ten years and so the pace of change is slow when compared to other industries. Third, the products should have highly usable interfaces since the medical practitioners cannot be diverted by advanced technology.

Healthcare systems research and development is multi-disciplinary in nature but what is noteworthy is that over the years software technology has emerged as a key force behind healthcare systems and solutions. In order to boost its software capability and drive innovations through effective management of software technologies, UHS established an R&D Center in India in the late 1990s. This center works with UHS R&D centers in the U.S. and Europe and primarily contributes by way of deploying its software R&D capabilities.

This case study investigates how UHS leverages its India R&D Center for its business competitiveness, especially for innovative capability and firm flexibility. In September 2005, I interviewed several senior managerial and technical people at UHF R&D Center in India, Europe and the U.S. to obtain first-hand perspectives on the focal aspects of the case. Table 6.4 provides details of the interviews conducted.

Table 6.4: Details of Interview Conducted at UHS

#	Position/Role	Location	Date of Interview	Mode of Interview
1	Director, UHS R&D	India	September 6, 2005	Face-to-Face
2	Project Manager, UHS R&D	India	September 8, 2005	Face-to-Face
3	Program Manager, UHS R&D	India	September 8, 2005	Face-to-Face
4	Senior Technical Leader, UHS R&D	India	September 8, 2005	Face-to-Face
5	Technical Leader, UHS R&D	India	September 8, 2007	Face-to-Face
6	Technical Architect, UHS R&D	India	September 8, 2005	Face-to-Face
7	Software Architect, UHS R&D	India	September 8, 2005	Face-to-Face
8	Lead Architect, UHS R&D	India	September 8, 2005	Face-to-Face
9	R&D Manager, UHS R&D	Europe	September 30, 2005	Face-to-Face
10	R&D Manager, UHS R&D	Europe	September 30, 2005	Face-to-Face
11	Director, UHS R&D	USA	January 17, 2006	Face-to-Face

6.3.2 Offshoring of R&D by UHS

The UHS R&D Center in India was established in 1997 primarily to provide software R&D capacity to various UHS product divisions. The UHS R&D Center is part of UHS's India subsidiary. The interviews suggest that access to software R&D talent at low cost structures was the primary motivation for setting up the UHS India R&D center. Since software has increasingly become a crucial factor for UHS's product competitiveness, the large scale of talent available in India has permitted the company to expand its software R&D capacity at low cost. Since its establishment, UHS's India R&D center has evolved from being a mere resource center to a large software competence center. The UHS India R&D is ISO 9001 certified and was assessed at Level 5 of the Capability Maturity Model of the Carnegie Mellon University's Software Engineering Institute. As of September 2005, the India UHS India center employed nearly 300 R&D engineers who mainly performed software R&D for a range of advanced healthcare products and solutions.

UHS India R&D is positioned as a software competence center and operates as a partner to the various UHS product groups. From the initial R&D activities related to UHS's X-Ray product that started back in 1997, the India R&D center now contributes to the R&D programs of eight different product groups spread across USA and Europe. According to senior UHS R&D managers in the U.S. and Europe, access to a large pool of R&D resources at low cost is important because of growing R&D expenses and the diversity of software R&D skills required. UHS India R&D center serves such needs very well.

6.3.3 Organization and Management of Offshore R&D

This section covers three aspects of the UHS's offshore R&D activities in India: the governance structure UHS employs for its offshore R&D center in India, quality and dynamics of the relationship between the UHS R&D center in India and the other UHS headquarters and other R&D centers, and importantly, how UHS allocates work to its R&D center in India.

6.3.3.1 Structural Characteristics

The UHS India R&D Center is organized around different product groups like X-Ray, MR, Ultrasound, Cardiovascular Systems, etc. It also houses capability platform groups that are common to different modalities as well as hosts R&D for healthcare informatics groups that develop diagnostic packages. UHS India R&D does not have any product-market mandate of its own. It also does not have its own budget. Instead, it operates as a cost center and at the R&D activities at UHS India are funded by the various UHS product groups in the U.S. or Europe. The funding provided usually corresponds to a certain headcount budget. The UHS R&D teams in India are supported by a Director but their R&D activities are managed by program managers located either in Europe or the U.S. In other words, the India organization is engaged in distributed R&D activities with ultimate accountability for the R&D programs lying with program managers located elsewhere.

The type and volume of R&D activities allocated to UHS's India R&D teams are determined by the R&D organizations in the U.S. or Europe. The India R&D center also undertakes R&D projects aimed at exploring and developing new technologies. Such exploratory R&D projects are funded by UHS's Corporate Technology Office, usually in response to proposals submitted by the UHS India R&D teams. In general, the work allocated to the UHS India R&D organization concerns software R&D. However, the flow of work into the India R&D center is not automatic. Instead, the senior managers at UHS India R&D organization engage in 'business development' activities to generate work for their respective groups by positioning the Center's software R&D capabilities to the R&D centers in the U.S. or Europe. Usually, the allocation of R&D work to India is accompanied by a longer-term development roadmap with the aim to build competency-based ownership, and is often a negotiated outcome between the managers from across the locations. It seems that there is a corporate mandate within UHS to leverage India, especially for software R&D capability but it has not yet been fully operationalized. Figure 6.7 depicts the governance structure for UHS's offshore R&D center in India.

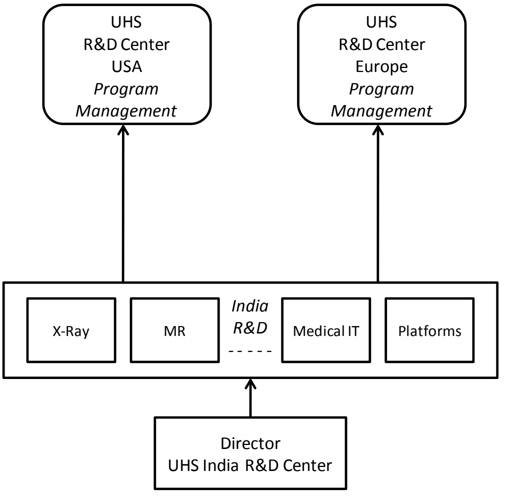


Figure 6.7: Organization and Governance Structure for Offshore R&D at UHS

6.4.3.2 Relational Characteristics

The India R&D center has extensively worked with the UHS R&D teams in Europe, and hence my investigation focused primarily on assessing the relationship structure and dynamics and its impact on the contributions the India center makes. The relationship between UHS R&D teams in India and Europe has evolved over a period of time. Evidently, the relationship has matured from initially being guarded and tightly controlled to a trusting and open relationship more recently. Describing the progression of the relationship, the Director of the UHS India R&D Center observed:

> *The relationship between the India R&D organization and our counterparts in Europe has gone through stages – honeymoon, despair, expectation setting, and trust. When trust is high, it positively affects our ability to collaborate and contribute.*

In the formative stage of the relationship, low cost structures at UHS India R&D constituted the most compelling reason to transfer work and so the need to feel assured on competence and quality was really high, as articulated by an R&D Manager at UHS Europe:

> *When you start a new cooperation, you need to manage technical people. To start with, one has an apprehension whether people over there can also do as good a job as we do.*

The need to get assurance and 'manage people' seems to lead to tight controls, which many at the India Center consider as micromanagement. However, as several informants on both the sides observed, the relationship currently is quite cordial and professional and is characterized by trust and openness. The interviews findings suggest that there has been a transition in how the people in UHS Europe perceived the India R&D teams, as exemplified by the following remarks of a Senior Technical Leader in India:

> *There has been a transition from customer to a partner type of relationship. Earlier, we had to validate our decisions with them. Now, we own things and work in a collaborative fashion, although sometimes we face policing from there, which does not feel good.*

Conversations with UHS R&D Managers Europe also suggest that increasingly they treat UHS India R&D as part of their own organization. However, the engagement bears signs of a mother-daughter relationship, which is seemingly a source of tension. The tension arises primarily because the budgetary controls and decision-making rest in Europe. On one hand, R&D engineers in India have their own aspirations and desire clarity on the scope of their involvement, while on the other hand the senior managers at UHS in Europe believe that the current level of experience at the India R&D Center is inadequate for participating in strategic roadmapping and complete product architecture. However, as observed by many informants, the UHS R&D organization in India is gradually gaining more acceptance and inclusivity within UHS. An indicator of this is how the budget allocation has changed over the years. Earlier, the budget allocation was based on the count of technical resources needed but now the UHS R&D division in India has been empowered with a fixed budget, which gives it some leeway in hiring, training and planning the overall resource development and deployment.

6.3.3.3 R&D Task Allocation

The engagement model between the offshore R&D center (UHS India R&D) and the UHS R&D centers in Europe and the U.S. follows sort of a push-pull approach. Various product groups within UHS offshore R&D to exploit the low cost technical resource pool in India. At the same time, the UHS R&D center in India constantly scouts for work, "selling" its value proposition of low cost, high quality and scalable software R&D capability to the various product groups.

An examination of work allocation reveals that there are several criteria that are used to engage UHS India R&D. First of all, the India center has significant software R&D capability and hence is often called upon to perform software development work. Second, the medical product R&D requires clinical domain knowledge, which is not yet sufficiently available at the UHS India R&D center. So, the nature of R&D work allocated to the teams in India is functional and technical in nature. The complexity of work also seems to drive work allocation, since the teams in India are relatively less experienced when compared to R&D resources in the U.S. or Europe. But, besides these, the availability of competence pool also becomes a factor especially for responding to the emergent needs. Explaining aspects related to work allocation, the Director of UHS India R&D noted:

> *Allocation of work is based on availability of resources and competence. Also, in those cases where a brand new software competence is required, usually the work comes to UHS India R&D. Then, there are opportunistic needs. Someone says, hey guys, can you help me with this? Normally, we say, no, but at times we undertake the work because we hope that later some bigger work will materialize.*
>
> *We do not do any hardware work. We do applications software, database engineering, and device drivers types of work. We don't do clinical applications because that requires domain knowledge. We have no experiential knowledge on how the healthcare systems around the world work. We develop functional packages, like study of heart, which is independent of region.*

Conversations with R&D managers in Europe confirm the above described criteria for work allocation but reveal more about how they have actually engaged UHS India R&D. Consider, for example, the remarks of one R&D Manager in Europe:

> *To start with, have clear specs for the global R&D teams and when over a period of time the required competence develops, when people can develop requirements themselves, increase their responsibilities. My experience is that knowledge build-up takes time, and the same is the case with relationships.*

Another R&D Manager from Europe, when discussing the topic of work allocation, expressed similar considerations:

> *Start with a well-defined need, typically in reengineering area to incorporate new technology. That way, teams at UHS India R&D ramp-up knowledge and later can also do feature development. Because people in India are away from the markets, we don't allocate them certain type of work like clinical development. In Europe and USA, we have domain experience whereas people in*

> *UHS India R&D are good in technology. At systems level, people in Europe and the U.S. have deeper expertise.*

Interviews with numerous informants suggest that currently the UHS India organization performs software R&D that is not domain expertise intensive and that does not require proximity to market. Take clinical decision support systems, for example. It is a new thing on the market, does not need domain access and proximity to market, and is software centric. UHS India R&D works on technical aspects of products to introduce new features and capabilities, or improve the existing products by enhancing their capabilities and performance, with directions from R&D organizations in Europe or USA. The India R&D center is also engaged in the development of generic systems such as those for picture archiving and connectivity for imaging products, creation of suite of generic components for UHS's healthcare IT systems. According to an R&D manager in Europe, nearly 50% of healthcare informatics R&D is now being done in UHS India R&D.

However, in addition to such criteria as core versus non-core, hardware versus software, and domain intensive versus domain neutral, there are further considerations for work allocation. Take, for example, the case of an imaging platform, which is used across all UHS modalities such as X-Ray, MR and Ultrasound and is owned by a team in Europe. The evolution of R&D activities pertaining to the imaging platform at UHS India R&D illustrates well the progressive nature of the offshore R&D engagement and the associated work partitioning considerations. A Project Manager associated with the imaging platform development at UHS's India R&D center provided insights on the genesis and growth of the R&D program:

> *UHS has different modalities like X-Ray, MR and Ultrasound, which have their own independent functionalities. But they share a common set of functionalities like image capturing, image storing, image transmission, and image presentation. Earlier each modality had their own implementation of these, but there came about a program to develop a common software platform for all these across modalities, called Medical Imaging Platform (MIP). Such a generic platform provides cost benefit and speed as it serves multiple modalities.*
>
> *The collaboration on MIP started about 6 years ago with a small activity on testing of components, more as a feeler for the team in Europe. A couple of people were also involved with the core job but were located onsite. While the people in Europe recognized the need for MIP, it was not a priority for them given other core product related activities that they were occupied with. Cost and resources*

> *were also issues. So, gradually, as the team in Europe felt assured about our capability, UHS India R&D became an easy source for more such work because it entailed a low risk way of generating confidence with the offshore model.*
>
> *The MIP suite has five layers and except one, all the layers are owned in India. The bottommost layer was originally done in Europe but is currently maintained by a team in India. Another layer that involves database technologies was identified as a value adding layer by the teams in India and added to MIP. Also, a layer that helps address field service was conceptualized and developed by the India R&D organization, and added to the suite.*
>
> *Now, the allocation of work is based on the ownership of the MIP suite layers. Earlier, however, when collaborative work was happening, work allocation was an issue. All MIP layers are interrelated and have to interact with one another. There was a time when the work for parts of the layers happened here and part there, and this was problematic.*

The case of MIP suggests that work allocation to UHS India R&D also involves additional considerations such as current state of the product or components, existing priorities for the teams in Europe, task complexity, and the criticality of the product or component for the customers or markets. However, one thing is clear, though, that there is an increasing tendency to allocate work to India based on an ownership model than distributed development which involves interdependencies. An R&D Manager from Europe provided an additional perspective:

> *Medical Systems is a special domain and that is why the ramp-up in India has been slow. We are still struggling in terms of what type of work we should outsource to UHS India R&D.*

During my visit to UHS India R&D Center I found that the teams do quite a lot of software testing work. Since thorough testing is required for healthcare systems products, given their reliability and safety requirements, and due to a strong process culture at UHS India R&D, perhaps allocating testing related work to teams in India is a natural choice for most R&D managers in the U.S. or Europe, given the difficulties they experience in deciding what kind of work to send offshore. Also, because of several acquisitions UHS has made, developing a unified work flow has become important for the company and the interviews suggest that such work is often allocated to the India R&D center.

Globalization of R&D

Software is increasingly becoming the unique selling point for the medical systems products and in view of this UHS India R&D center is increasingly seen as a software competence center for UHS. UHS India R&D, in its attempt to generate additional R&D work, highlights its software R&D capability and low cost resource pool. However, the low cost factor does not seem to be an overriding attraction for the R&D managers in Europe. Consider the following two, contrasting quotes from the interviews.

> *We have to have at least comparable level of productivity. Otherwise, the cost advantage does not hold good.* – Program Manager, UHS India R&D

> *Cost is really not a factor, given the productivity and learning curves offset the low cost advantage.* – R&D Manager, UHS Europe

Conversations with informants at UHS also brought forth an interesting perspective on how national business culture might have a bearing on engagement model and work allocation. A Lead Architect at UHS India R&D, who has worked with teams in both USA and Europe, observed:

The work allocation philosophies vary between the European groups and the American groups. The Europeans are guarded in their approach in the way they choose to start work here. They have a stronger belief in the core versus non-core approach than the Americans. For American groups, time to market is a critical factor than the engineering considerations. And, if they believe that you can assist them with their time to market needs, even if the work is core to them, they will not hesitate to part with it – at least they will part with it faster than the Europeans.

6.3.4 Offshoring of R&D and UHS's Innovative Capability

This section presents findings related to (a) generation of innovation by UHS India R&D Center and (b) transfer of knowledge from UHS India R&D Center to UHS R&D Labs in Europe.

6.3.4.1 Innovation Generation by UHS India

UHS India R&D center does not yet have ownership for any product that is sold in the market. In other words, it does not have any product-market mandate. Instead, it collaborates with the various UHS product groups and contributes by performing software R&D for them. Different product groups determine the scope of software R&D that they want UHS India R&D to perform for them and accordingly provide funding to the groups in India. Since involvement of UHS India R&D is based on works assigned to them by UHS product groups, which are also often time bound, the R&D teams in India have to really work and innovate within a boundary. Interviews indicate that the innovations produced by the UHS India R&D are by and large incremental and technological in nature.

Software is increasingly seen as the unique selling point for healthcare systems, and given that a significant volume of software development is contributed by the India R&D organization, its ability to innovate for UHS assumes importance. However, having to work within a boundary, as discussed above, seems to determine the innovation span for UHS India R&D teams. Moreover, since the R&D teams in India are away from customers and markets, it has a bearing on their ability to innovate or the type of innovation they can generate. So, generally, their expertise is called upon for keeping pace with changing technologies, incorporating them into products, and transforming products with new technology. However, in spite of having to work within a time-boxed boundary, the UHS India R&D center has made some significant innovation contributions. Even though these product and process contributions are incremental in nature, they seem to be important for UHS.

For example, in the five-layered MIP suite described earlier, the value added framework for field services was fully conceived and developed by an R&D team in India. The MIP suite is used across many UHS imaging products such as X-Ray, MR, Ultrasound, etc. Explaining the innovation contributions of the India R&D organization to the MIP platform and the challenges involved in producing such innovations, a Technical Architect at UHS India R&D observed:

> *MIP is used across all the modalities of our products like X-Ray, MR, Ultrasound, etc. Such a generic platform provides cost benefit as it serves multiple modalities. However, it is a challenge to make a generic platform, which will serve the needs of all the modalities. Balancing flexibility and performance is a challenge. We developed and added the field service framework in MIP. Such a framework was not part of MIP before but was there in our X-Ray product. But a generic field service framework architecture based on new technology was developed by us from scratch. What is unique about this framework is that it provides remote service capability. Because healthcare equipments are expensive and have a long life span, service software is essential. The ability to provide remote field service saves expenses on maintenance, which is very crucial. We can also do preventive diagnostics and maintenance.*
>
> *Also, another layer that was initially developed for the MR product was later incorporated by us into the MIP platform as a distinct layer after we demonstrated a POC. This layer, which involves advanced database technologies, had many performance problems.*

> *We developed a .NET/SQL server based database solution that delivered significantly improved performance.*

R&D Managers in Europe readily acknowledge that the field service framework developed by UHS India R&D is widely used within UHS and has extended the remote service capability that was important. Flexible and extensible architectures are the key for UHS products, especially in the wake of changing technology, and UHS India R&D is called upon to transform legacy products into new technologies. According of an R&D Manager in Europe:

> *We started MRI in 1985 and over time software grows and technology changes. So, we have to reengineer the product to make it flexible and low cost. Earlier, for example, we used computers that one of our divisions manufactured, then we shifted to DEC, and now everything is Microsoft based. We have to be able to absorb new technology trends and for that, we need competence centers like UHS India R&D.*

The Director of UHS R&D in India provides additional perspectives while explaining the nature and importance of innovation contributions of his organization:

> *In medical systems, for reasons of cost and obsolescence, we are moving to the Microsoft Windows platform. The quantum of data in a medical systems product is in terabyte range. The PC/Windows platform is not yet very powerful and so we need to do innovative software design to take care of high performance requirements. To match the performance levels of a graphics workstation is quite a challenge. On that front, we have done quite a few algorithm level innovations and overcome the constraints of a PC based platform. Primarily technical innovations – design of databases for meeting performance requirements.*
>
> *For example, in large hospitals, many doctors access patients' records over a common network. Data sizes are huge. Typically, on a PC platform it would take several seconds before data appear on the screen. It is not a problem of network bandwidth but processing at machines that is a bottleneck. We have addressed these by incorporating new algorithms to improve the performance. We have changed the way an image is taken from the database, the way it's transported over the network, and the way it is processed at the machine.*

The counterparts acknowledge such contributions as innovative and important, as is testified by the remarks of an R&D Manager in Europe:

> *UHS India R&D developed an algorithm for speeding up image processing and transmission. New software with new technology…new database which is faster especially as the size of the data is growing and the need for flexibility is high.*

The Radiology Information System was largely developed and deployed by UHS India R&D in the Asian region. Also, the MR and Cardiology Information System Applications were fully developed in India. UHS India R&D has also introduced componentization and new technology in the CATH lab management system, and improved analysis of blood flow in the MR system by enhancing the application packages with color images. In addition, UHS India R&D developed a patient docking platform for MR using a plug-and-play component architecture and its associated firmware and software. This idea was picked from a cardio-vascular system that had similar features.

Besides CTO funded projects, teams at UHS India R&D are also called upon to explore, evaluate and integrate new technologies in medical systems products, as described by an R&D Manager based in Europe:

> *We do small scale competency development at UHS India R&D to explore new technologies. We are more tightly coupled to market commitments. We are under pressure to deliver and also have restricted headcount, whereas UHS India R&D has resources and flexibility to pursue innovative projects. For example, when Microsoft came up with the .NET platform, the task of feasibility study and migration of several UHS products to the .NET platform was entrusted to UHS India R&D.*

Interviews with UHS R&D managers and technical leaders indicate that the India R&D organization has introduced quite a few process innovations since it drives the software product creation processes. According to the Director of UHS R&D in India, key process innovations include introduction of Rational Unified Process (RUP); use of V-Model, which improves effectiveness and output quality; adoption of daily build processes, which help effective synchronization and integration in multi-site development projects; metrics based project and product quality management; and a host of automated tools. However, he was also quick to add that many of these process innovations were in response to the challenges UHS India R&D experienced by virtue being a remote R&D site:

> *When you have a distributed workforce, maintaining communication becomes very difficult. So unless process forces you to maintain communication, it won't happen because people by nature are undisciplined. We were at the receiving end and did not have the domain competence. So, we built up other competence such as process competence. I think we realized the need for discipline first, and later it was forced on our partners. Once they started doing it, it was considered helpful. Because we are a remote site, it already forces us to be innovative in the way we work. We had to compensate for lack of domain competence through process competence.*

Improving its innovative performance is a key objective at UHS India R&D. UHS India R&D currently measures its innovation contribution in terms of the number of customer solutions proposed versus accepted by its partners in the U.S. and Europe. Also, UHS India R&D systematically leverages software reuse and exploits the time zone differences between Europe, USA and India to accelerate speed of innovation. However, even though patents are considered as an important innovation measure within UHS, its R&D Center in India did not have any patents granted to it as of September 2005. In fact, from the interviews it appears that as of September 2005 the total number of patents filed by UHS India R&D was less than 10. With a view to establish a culture for innovation, UHS India R&D also organizes an annual Innovation Day and gathers inputs on innovations drivers for products through structured questionnaires. But so far any substantial, market differentiating product or process innovation has not come out of India. On the contrary, given the age and size of UHS India R&D, the volume and quality of innovations it has produced leaves much to be desired. One senior manager at UHS R&D India concurs with the above assessment but cites the lack of customer proximity as one of the main problems for UHS India R&D to contribute innovative outputs:

> *We are by far the most advanced center in software within UHS. In some areas, we are leading the innovation. For example, in medical systems, we are leading remote diagnostics. But the ratio of our innovation contribution to resources is small.*
>
> *Context is the key for innovation and customer intimacy crucial. Innovation has to be aligned to the demographic profile of the customers. For example, we are doing a mobile healthcare project targeted at population in rural areas, where healthcare facilities are abysmal and expensive as well. We use satellite links for remote diagnostics. This is a case where a resource constrained situation led*

> *to innovation. Diversity is to be harnessed. We need to develop products with diversity in mind.*

Interestingly, at UHS India R&D there appears to be a considerable variation in assessing what constitutes innovation. According to the Director of UHS India R&D innovation does not mean something high-tech; it means something different. Whereas another senior manager at UHS India R&D offers a very different perspective:

> *Even though we define the platform, design the architecture and develop new features, I won't call that innovation. To me, innovation is something that creates a new business. Producing products for existing markets is not innovation, although it requires creativity. Even to sustain the existing markets, you need cost and feature innovation but that is not real innovation.*

So far, even the CTO projects done by the India R&D center have not produced any significant innovation for UHS, even though these are funded by the corporate technology office on a competitive basis in response to submitted proposals.

6.3.4.2 Knowledge Transfer from UHS India R&D Center to UHS Headquarters

The UHS R&D centers in Europe and USA own products and carry out R&D for them, whereas the India R&D center feeds software R&D capabilities for products the other centers own. With nearly 22% of the total UHS software R&D resources located in India, naturally a considerable amount of learning and new knowledge creation happens in India. Obviously, then, assimilation of this learning and knowledge into the larger organization assumes importance for UHS' innovative capability. Especially in the arena of software R&D, since the India organization performs a bulk of R&D for UHS, effective learning and knowledge integration is important, given that increasingly the product competitiveness is driven by software.

In order to facilitate reverse learning and knowledge integration, there are several formal and informal mechanisms in place at UHS. For example, for the MR product, there is a global architecture team spanning Europe, India, and USA that acts as a forum for ideas and knowledge exchange. Likewise, there are platforms like Architecture Board and Business Forums that provide a conduit for exchange of learning and knowledge. UHS India R&D also extensively employs electronics infrastructure for information dissemination and learning and knowledge sharing. For example, all teams at UHS India R&D use Intranets and e-groups for disseminating information and engaging in discussions. Several groups also publish newsletters that contain new ideas, technology trends, etc and are circulated within the larger UHS entities. UHS India R&D also allows its employees to take a job rotation after 18 months and believes that this leads to knowledge diversity, which, in turn, gives it the flexibility to staff projects effectively.

As part of the high maturity software processes at UHS India R&D, all R&D work is documented and this results in codification of knowledge that is embedded in the products. A Senior Technical Leader at UHS India R&D observed:

> *I believe we follow quality processes much more rigorously here than our counterparts do. If you look at legacy code, there is hardly any documentation available. But whatever gets developed here has to have documentation.*

The feasibility studies and new feature proposals authored by UHS India engineers also results in codification of ideas, learning and knowledge. UHS India R&D also organizes Partnership Days where people from the other R&D locations participate. Partnership Days provide a forum for ideas and knowledge exchange in addition to an opportunity for the product groups to understand UHS India's software R&D capability. The India R&D organization also organizes workshops at other UHS R&D locations for exchange of ideas and knowledge. For example, for MIP's field service framework that the India organization owns, UHS India R&D conducts workshops in Europe and USA, where the team also gathers new requirements for the framework. At such workshops, people from the other modalities participate.

However, in addition to formal mechanisms, frequent exchange of people from across locations and telephonic conversations provide informal ways of interaction, learning and knowledge exchange. An R&D Manager from Europe remarked:

> *There is a lot of traffic between Europe and India which includes discussions on new ideas and new technological exploration. People also write documents and reports but I know the most effective way to share knowledge is personal exchange, so the senior people meet regularly.*

In terms of learning and knowledge integration, it is widely believed within UHS that the UHS India R&D model presents an advantage as it promotes exploitation of cross-group synergy by virtue of the fact that it performs R&D for many products under one roof. An R&D Manager from Europe observed:

> *Other product groups are present here and it facilitates knowledge and information exchange across groups. For example, we have a medical components group in Europe that gives us components that we integrate. That group also outsources work to UHS India R&D.*

> *Now, everything is integrated at the R&D Center in India under one roof. Now, we don't have any integration people in Europe.*

UHS India R&D being a software competence center, and having achieved a high process maturity level (CMM level 5), it provides consultancy on software engineering best practices to all groups in UHS. Such consulting engagements allow for transfer of learning and knowledge from India to other locations. Also, since UHS India R&D has done considerable work and acquired proficiency in the user interface arena, R&D teams in Europe have learned new ways of developing user interfaces. For example, the dynamic user interfaces with progressive viewing feature in MIP was influenced by teams in India who had used such technology in other projects.

In investigating the extent and type of learning and knowledge integration from UHS India R&D into the larger UHS, it appears that it is mostly software engineering and technology related learning and knowledge that gets exchanged. A juxtaposition of the two aspects seems to be at play as far as reverse learning and knowledge integration is concerned. One, the R&D resource pool at UHS India R&D is relatively inexperienced and is still ramping-up its domain specific knowledge. And, second, the other locations may not perceive learning and knowledge exchange related to new software technology as valuable for them. Also, an inclination to learn may be missing. The interview with a Technical Lead at UHS India R&D offered a hint to this effect:

> *For them to learn from us, they need to be convinced that we have something good. Nobody wants to reinvent things – everyone wants to reuse as much as possible. This happens through the intensity of interactions. However, sometimes I find that prior knowledge hinders openness to new ideas.*

Also, while the stated potential of cross group synergy at UHS India R&D exists, it does not yet seem to have panned out in terms of tangible benefits, except in occasional instances of imitable innovations like the development of the dockable trolley for MR produced by UHS India R&D. Managers at UHS India R&D share this assessment, as is testified by the following remarks of a Project Manager:

> *At UHS India R&D, we can leverage synergies because we have different groups under one roof, knowledge sharing happens better, although it is early to say it produces real impact.*

6.3.5 Offshoring of R&D and UHS' Organizational Flexibility

The UHS India R&D Center is a competence center that collaborates with the various healthcare product groups, providing them with a range of software capabilities. For reasons of qualified knowledge resources at low cost structures, the Center has grown possess nearly 22% of the total software R&D resources within UHS. From the interviews it appears that the ability to ramp-up and ramp-down resources quickly on projects offers flexibility that UHS India R&D's partners value. Such flexibility also releases bandwidth at other R&D locations and allows more experienced engineers there to focus on other priorities, as observed by an R&D Manager from UHS's European operations:

> *The resource flexibility at UHS India R&D is quite helpful. In our own organization, we have fixed headcount. But in UHS India R&D, we can ramp-up fast with good competence. So, we can offshore software R&D work to UHS India R&D and focus ourselves on core medical systems domain work.*

Conversations with informants at UHS India and other R&D locations suggest that often when a product is matured or needs to be reengineered with new software technology, UHS India R&D is entrusted with such work. For example, the MIP platform was earlier based on Java but had to be moved to C# because Microsoft refused to provide support on Java. UHS India R&D was entrusted the responsibility for this transition and asked to keep pace with Microsoft's roadmap. Similarly, when a new software technology is to be explored and evaluated, usually UHS India R&D is called upon for such tasks. Also, because of price based competition and cost erosion that UHS encounters for its products, UHS India R&D offers an attractive option for adding more features and capabilities at low cost. In view of an R&D Manager in Europe:

> *If you look at medical equipment, then the key things are – database server for image storage, image presentation, image transmission, and the scanner platform. We are not able to ourselves reengineer things due to market pressure, so we come to UHS India R&D to develop new features and reengineer. In Europe, we shift priorities based on market needs and engage people here accordingly. That sometimes leads to a sense of disengagement here at UHS India R&D.*

It appears that some cultural factors in India also add to the flexibility. For example, managers in both Europe and India recognize that the young resource pool in India is quick to learn and flexible in terms of travel and work related commitments. According to the managers, the engineers in India stretch themselves for the successful accomplishment of project goals and also demonstrate flexibility in learning and adopting new technologies. There is also a common belief within UHS that due to their heritage, people at other R&D locations exhibit inertia to adopting new technologies and in general are resistant to change. Contrasting the differences between UHS India R&D and other locations, a Technical Lead in India remarked:

> *People in Europe have deep domain expertise. But we are very good in technology management. People in India want to work on new technologies, whereas in other locations people want to stick to what they are familiar with. This can be exploited for technology management at low cost.*

6.3.6 Impressions from UHS's Offshore R&D Engagement

Software is increasingly becoming important for healthcare products and systems, and it appears that the scale of high quality talent available in India at low cost structures is providing considerable R&D capability to UHS. UHS India R&D Center's charter is to augment the innovative capability of its partners in Europe and USA by leveraging its innovative capacity for software R&D. Over the years, the UHS India R&D organization has undoubtedly transitioned from being a mere resource center to a competence centre with proven execution capability. But the next phase of transition to a high-impact innovation center seems still some way ahead.

There are a few examples of incremental innovations contributed by UHS India R&D, covering product, process, architectural and technological innovations. However, the overall innovative performance of the center measured in terms of innovations to resource ratio or the number of patents filed is not yet comparable with the UHS's other R&D center. And, while UHS India R&D's role and contributions are well acknowledged by its partners, it has yet to be credited for having produced major innovations for its partners. According to the informants at UHS India R&D, their ability to produce major innovations is impacted due to lack of domain knowledge and distance from the markets. The resource base at UHS India R&D is relatively less experienced when compared to the other, more established R&D locations, and this is reflected in work allocation. The fact that the UHS India R&D center is dependent on other R&D locations and product groups both for funding and work leads it to operate within pre-defined boundaries and primarily play an execution role.

Also, UHS India R&D's positioning with the other R&D locations seems to be preventing it from achieving its intended status of a high-impact innovation center. Consider, for example, the following remarks of a Program Manager at UHS India R&D:

> *Our partners can offload some of the work that is not core to UHS India R&D – that way the resources there would be able to work on latest technologies and focus on core competencies.*

Understandably, such a positioning would hardly advance the India R&D organization to its desired situation of eventually emerging as a software innovation center for UHS. Instead, it will promote a tactical utilization of the software R&D capability available in India. Likewise, the current modus operandi, which involves tapping the resource base at UHS India R&D to free up innovation capacity at other locations, must also change for UHS India R&D to emerge as a true source of innovative capability for UHS. Thus, a systematic approach to work allocation and competency building would be required to transform the innovative capacity in India into innovative capability for UHS. However, notwithstanding its innovation track record, the India R&D organization's contributions to UHS products are not insignificant. For example, designing extensible and flexible software systems for medical systems products is quite a challenging endeavor as is the ability to keep pace with rapidly changing software technologies.

With the growing concentration of software R&D activities at UHS India R&D, reverse learning and knowledge integration assumes critical importance for UHS. However, given the intangible nature of learning and knowledge, it is difficult to quantitatively and accurately assess this dimension. This is also complicated due to an interactive nature of learning. Nevertheless, the interview findings provide some clues and suggest existence of a rather weak situation of reverse learning from India to the other UHS R&D locations. Although many formal and informal mechanisms to facilitate learning and knowledge integration exist, the reasons for invisible reverse learning could be many. One, since work has moved from other locations to India, R&D engineers at those overseas locations already possess the necessary knowledge. They are also relatively more experienced and have the domain knowledge. Second, since UHS India R&D is primarily involved in design and development of software for UHS products, by and large such activities may not give rise to opportunities for new learning and knowledge transfer to the other locations. Additionally, prior knowledge at other locations may dampen their openness and serve as hindrance to learning.

In such areas as software process improvement and user interface development, where UHS India R&D has demonstrated distinct capabilities, learning and knowledge exchange did indeed take place, as the interviews confirm. Also, UHS India R&D provides software process consulting to other UHS organizations and thereby diffuses learning and know-how within the larger company. However, by virtue of the fact that the UHS India R&D center hosts R&D for several product groups, the promise of cross group synergy exists but there is no evidence yet that it has yielded any significant advantage for UHS.

Owing to the availability of a scalable software R&D talent pool, UHS India R&D offers significant operational flexibility to its partners at other locations as it can quickly ramp-up resources for new projects and re-deploy those resources when the situation demands. Also, UHS India R&D helps free up innovation capacity at other locations by taking responsibility for products and components that its software R&D resource pool can handle without need for access to market or domain knowledge. Moreover, the young and aspiring resource base at UHS India R&D instills a certain cultural and cognitive flexibility for UHS, which unfolds by way of quick learnability, rapid exploration and adoption of new technologies, as well as work hours and travel related flexibilities.

It is understandable that the lack of domain knowledge and accumulated experience poses some constraints for offshoring of complex medical systems R&D work, which has relatively long R&D cycle and product life span and often requires proximity to lead customers. But these constraints could be overcome by strategically leveraging offshore R&D for technological innovations and organizational flexibility to boots marketplace performance.

6.4 CASE STUDY IV: CORDYS

Cordys is a software company with products in the areas of business process modeling, business process management, inter- and intra-enterprise collaboration and integration, encompassing such technologies as XML, Web services, and SOA Grid. Founded in 2001, Cordys is a privately held software company having its headquarters in Putten, the Netherlands. The company has introduced several cutting edge products and solutions in the market in a short time since its inception, and carries out bulk of its R&D in India. I interviewed several key people in Cordys during November – December 2005 to understand how the company leverages its offshore R&D center to derive innovative capability and firm flexibility. Table 6.5 provides details of the interviews that have informed this case study. Each interview lasted more than an hour on average.

6.4.1 Background and Context

Cordys is a software company that develops collaborative software solutions to deliver superior levels of agility, efficiency and responsiveness to companies and their networks. Cordys was founded in 2001 by Jan Baan – an enterprise software pioneer who had earlier been the driving force behind the Baan Company, best known for its ERP software package. Headquartered in Putten, the Netherlands, Cordys has offices across the Americas, Europe and Asia, with key research and development operations in the Netherlands and India. Cordys is privately held and has nearly 550 employees worldwide. The mission of Cordys is to solve the IT implementation and change issues faced by today’s extended enterprises by enabling them to be more responsive to changing business conditions.

Table 6.5: Details of the Interviews Conducted at Cordys

#	Position/Role	Location	Date of Interview	Mode of Interview
1	Managing Director, Cordys (R&D) India	Hyderabad India	November 18, 2005	Face-to-Face
2	Chief Technology Officer, Cordys	Putten The Netherlands	December 1, 2005	Telephone
3	Head, Product Management, Cordys	Putten The Netherlands	November 28, 2005	Telephone
4	Product Manager, Cordys (R&D) India	Hyderabad India	November 18, 2005	Face-to-Face
5	Head—R&D, Cordys	Putten The Netherlands	December 14, 2005	Telephone
6	Product Architect, Cordys (R&D) India	Hyderabad India	November 18, 2005	Face-to-Face
7	Product Architect, Cordys (R&D) India	Hyderabad India	November 18, 2005	Face-to-Face
8	Director, Cordys (R&D) India	Hyderabad India	November 18, 2005	Face-to-Face
9	Director, Cordys (R&D) India	Hyderabad India	November 18, 2005	Face-to-Face

In fulfillment of its mission, Cordys offers a range of products, solutions and services. Its main product is a SOA Grid based Business Process Management Suite, based on which it also offers SOA based customized business process management solutions for various industries. In addition, the company operates Cordys Developer Network – a collaborative meeting place for Cordys community (employees, users, customers and partners), a sort of social and knowledge network aimed at idea sharing as well as experience and knowledge leverage. Cordys products and services have been recognized by several prominent analysts such as Gartner and Forrester as visionary and leading edge offerings in the market.

6.4.1.1 Business Environment, Success Factors, and Strategy at Cordys

The superiority of Cordys products and offerings, as testifies by its industry leadership and recognition by analyst community, comes from the fact that its business process management suite—the Cordys platform—is technology neutral and completely agnostic to the underlying software environments. Of course, this is attributable to the unique product vision, its design and the underlying technologies. However, being a relatively new company offering an advanced product, Cordys faces the challenge of creating market awareness and acceptance for itself. Moreover, Cordys products and solutions are based on emerging technological paradigms such as service oriented architecture (SOA) and business process management (BPM). In fact, both SOA and

BPM are still in their early stages of development and adoption, and their technical standards are still evolving. This means that the company operates in the midst of unprecedented technological change. The company also faces stiff competition from several angles: software and IT infrastructure integration vendors such as webMethods, TIBCO and Vitria; infrastructure and application vendors like IBM, Oracle, SAP, BEA and Microsoft; and SOA Grid vendors such as Cape Clear, Fiorano and Sonic Software.

A key success factor for Cordys is to effectively manage the technology evolution trajectories and incorporate new technologies, as may be relevant, in its products and offerings in a timely manner. This also requires Cordys to watch evolution of standards and their impact on its technology strategy, and appropriately configure or adapt its strategy. Cordys is already an active participant in major standards forum such as W3C (World Wide Web Consortium), and it appears that technologically, Cordys is doing everything it can to maintain its supremacy vis-à-vis other competitive offerings. As regards the market acceptance and penetration of its products, Cordys has adopted a new marketing strategy concentrating on a select group of key customers in specific verticals. As part of this strategy, Cordys employs a solutions-centered and leverages its technology stack to solve specific business problems. Termed "Lighthouse Accounts" within Cordys, such a strategy allows Cordys to systematically establish its products by working with leading industry players. However, success with such industry-focused strategies requires strong partnerships with companies that can bring in the necessary domain expertise. Cordys seeks to achieve this through the Cordys Web – a network of partners and alliances that bring in complementary capabilities and advance Cordys' business objectives.

6.4.1.2 Research and Development at Cordys

Cordys being a privately held firm, information on its R&D budget or R&D intensity is not publicly available. Interestingly, however, a majority of its R&D resources– approximately 70% – are located at its R&D Center in Hyderabad, India whereas the remaining 30% are based in the Company headquarters in Putten, the Netherlands. A study of Cordys readily suggests that both product and technological innovation are crucial for Cordys.

The research and development (R&D) environment at Cordys is quite dynamic due to fast pace of technological and market changes. However, the research and development portfolio at Cordys is concentrated on a small portfolio of offerings around its Business Process Management Suite (BPMS). This means that the range of technologies that Cordys R&D has to deal with is not very wide when compared to R&D functions at large, multi-technology firms. Yet, because of the environmental dynamics the R&D function at Cordys really has to be agile in order to be effective, whether I terms of differentiating its products through new features and capabilities or handling the dynamics of standardization. Also, it has to manage its R&D budget quite efficiently, so that it can achieve a high R&D productivity. In addition, R&D's ability to closely work with customers and partners is vital to Cordys' marketplace success through continuous product and technological innovation.

6.4.2 Offshoring of R&D by Cordys

Cordys (R&D) India was established at Hyderabad in 2001 concurrent with the founding of Cordys in Putten, the Netherlands. The India Center currently houses nearly 75% of the company's R&D staff. It is commonly understood that the decision to locate a significant proportion of R&D in India was influenced by the Cordys founder Jan Baan's previous experience with India. Mr. Baan, who had earlier founded one of the leading ERP companies called the Baan Company, had set-up Baan Infosystems in India in the late eighties to leverage the Indian engineering talent for product development and customer support. At its peak, Baan Infosystems employed more than 1000 engineers and carried out nearly 50% of R&D for the Baan Company.

Cordys being a privately funded and relatively new company, operating in an environment of rapid technological change and intense market competition, the low cost talent availability in India has allowed it to quickly scale up its R&D capacity while burning cash at a relatively less rate. Since its inception, Cordys (R&D) India operation has grown to a size of more than 300 R&D engineers. From the interviews with Cordys executives it appeared that based on several considerations, setting-up a wholly owned R&D center was preferred as opposed to outsourcing to an R&D service provider. Also, many people who had worked at erstwhile Baan Infosystems moved to work with Cordys (R&D) India, thereby easing aspects related to relationships and cultural assimilation. In addition, these people brought in background in enterprise software product development. Remarking on the decision to set-up a wholly owned R&D Center, the Cordys India Managing Director, who has been associated with Jan Baan since 1987, said:

> *We thought in your own Center it is more feasible to train people in the way you would like to, you are able to manage them better, positively motivate them, encourage them, and channel their energies and interests according to what you need. Plus, of course, the IP related concerns are not there.*

Cordys India (R&D) provides a highly talented and motivated pool of people, who are able to tune in to the technical vision proposed by senior technologists and architects in the Netherlands and take upon the challenge of developing products and solutions. Whilst cost continues to be a driver, lately, Cordys has strategically leveraged the scale of available talent in India to support its growth plans. Commenting on the evolution of the Cordys (R&D) India, the Head of R&D at Cordys based in the Netherlands said:

> *If you want to be flexible, fast and not worry too much about the quality of people, then I think India is the natural choice.*

6.4.3 Organization and Management of Offshore R&D

This section explains how Cordys organizes offshore R&D, allocates work, and manages its R&D center in Hyderabad, India. Specifically, the governance structure employed for Cordys (R&D) India and the relationship dynamics of the engagement dyad are discussed. This is followed by an analysis of the engagement model and work allocation approach used by Cordys for its India R&D Center.

6.4.3.1 Structural Characteristics

Cordys (R&D) India is a cost center, engaged in performing research and development for its parent company Cordys, which is incorporated in the Netherlands. A team led by the Chief Technology Officer in the Netherlands decides the scope of work for Cordys (R&D) India. The R&D work is largely divided in two parts: ‘Pre-Development’, which involves concept development, product definition, and customer interactions; and ‘Development’, which involves product development. By design, the Cordys (R&D) India is responsible for the Development work, whereas Pre-Development activities are carried out by the R&D team in the Netherlands.

All customer facing groups such as product marketing, product management, pre-sales and sales are located in the Netherlands. A product management board serves as the coordination mechanism across the locations. Each component of the Cordys product suite has a product management designate and a dedicated R&D team, most of them located in Cordys (R&D) India. Chaired by the Cordys Head of Product Management, who is based in the Netherlands, the product management board is a virtual team comprising the customer facing groups and the product management representatives of the various Development groups. The product management board is responsible for requirements gathering and analysis, as well as prioritizing requirements for each product release. Figure 6.8 depicts the governance and organization structure as seen in the offshore R&D engagement dyad constituted by Cordys and Cordys (R&D) India.

Explaining the organization, the Chief Technology Officer of Cordys, based in Putten, the Netherlands, observed:

> *We have only one R&D center in Cordys, and that is in Hyderabad. The overall management is done from the Netherlands. We do pre-development at the Netherlands. In pre-development, we do very complex things, which involve concept development and sometimes*

> *even parts of the first release and then handover the work to India for productization, delivery, maintenance and support. Sometimes pre-development also happens in India but typically all components, howsoever complex they might be, are done in India.*

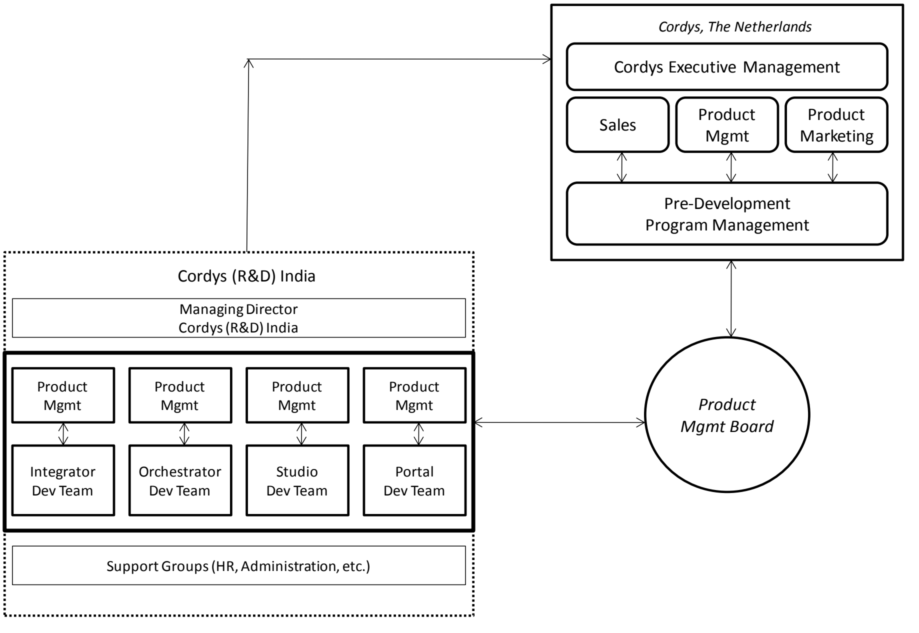


Figure 6.8: Organization and Governance of Offshore R&D at Cordys

6.4.3.2 Relational Characteristics

The relationship between Cordys in the Netherlands and its Offshore R&D Center in India is characterized by good communication, understanding, and productive global team work. Interviews with the informants at Cordys indicate that there is a high degree of trust and mutual understanding on both the sides. Despite the cultural differences, there seems to be a good cross-cultural assimilation between the two locations. In the words of a Director at Cordys (R&D) India:

> *There is a lot of mutual respect and good team work. The system works naturally according to the demands of the environment. We don't try to sort out the cultural differences – that's a given and we respect it.*

Conversations with the informants readily suggest the existence of a shared work culture characterized by transparency. Many people at Cordys (R&D) India have previously worked with their Dutch counterparts as part of the Baan Company. This long association has clearly served to establish trust and mutual respect that is readily evident in the relationship between Cordys and its R&D Center in India.

6.4.3.3 R&D Task Allocation

The model of engaging Cordys (R&D) India is based on a straightforward classification of work, which also determines the allocation of work between the locations. At Cordys, the activities are classified as Pre-Development and Development. Pre-Development activities include conceptualizing the product and developing the product architecture, research and proofs of concepts, feasibility analysis, and customer interactions with a view to understand their needs. The Development activities involve design and development of the components and features of the Cordys product suite as well as solutions. Typically, all pre-development activities are carried out at Cordys, the Netherlands, and all development tasks are assigned to the Cordys (R&D) India organization in Hyderabad. However, the work allocation based on this classification is not rigid and occasionally the India teams do carry out pre-development activities and the team in the Netherlands undertakes development work. Figure 6.9 illustrates the work allocation approach practiced at Cordys.

In explaining the principle and rational behind work distribution, the Head of Product Management at Cordys based in the Netherlands said:

> *There are two types of work: Pre-Development [R] and Development [D]. We evaluate new requirements, the time it will cost to provide the new requirement and when it is clear, we go to Development. Majority of Pre-Development is done in the Netherlands and Development in Hyderabad. But some Development also happens in the Netherlands and likewise some Pre-Development also happens in Hyderabad. Sales and customer facing organizations are in the Netherlands, and so it is natural. Also, the level of experience in the Netherlands is higher. Experience is crucial to the analysis of complex work.*

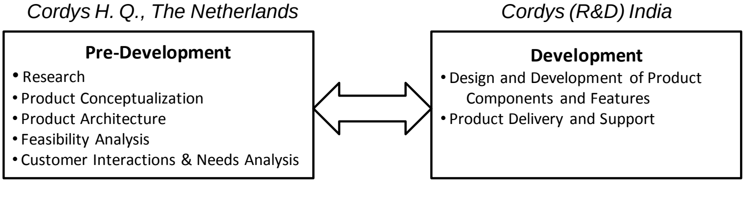


Figure 6.9: Division of R&D Tasks at Cordys

The division of work at Cordys seeks to eliminate task interdependencies to minimize the need for communication and coordination. Instead, the work allocation is based on establishing ownership. Commenting on the nature of contributions of the Dutch team and the approach to work allocation, a Director at Cordys (R&D) India said:

> *The team in the Netherlands helps us achieve breakthroughs, conduct research, develop PoCs, and does feasibility evaluation, leveraging their extensive experience. For example, to make our product platform neutral, we decided to develop our product purely based on XML. This kind of know-how usually will be called upon from the Netherlands. The Hyderabad team does not usually directly interact with customers. We don't want to split responsibility – it adds to a lot of overhead in terms of communications and coordination. We don't work on a project model; instead, we believe in allocating ownership.*

While using a classification of activities as pre-development and development, it is clear that the considerations related to communication and coordination are central to allocation of work at Cordys, as is exemplified by the following remarks of the Head of R&D at Cordys, the Netherlands:

> *Offshoring has to be strategic. You can't treat it as a bunch of people. If you did that, you would create a huge need for communication. That way, we think, you can't create the level of understanding that we need. So, we don't split ownership. Instead, we wish to have a single location ownership. That way you can drive the direction in which you want people to go much better because you steer them by objectives and not tasks.*

The engagement and work allocation model employed at Cordys suggests that the technology vision and leadership comes from Cordys headquarters in the Netherlands, and Cordys R&D in India executes on that. Interview findings suggest that senior technologies and architects in the Netherlands develop product vision and a high level architecture. Teams in Cordys (R&D) India have the ability to tune in to the vision and architecture conceived by experienced architects in the Netherlands, quickly grasp the high-level ideas and requirements, develop prototypes to validate and refine the ideas, and then develop the full product. In other words, the senior technologists and architects in the Netherlands lay the path for people in India who take over and walk the path effectively and correctly.

> *All productization happens in Hyderabad, which makes things easy and reduces cost. All support is also located in India. Because of the*

proximity of development and support, we are able to achieve better coordination and lower our overall costs.

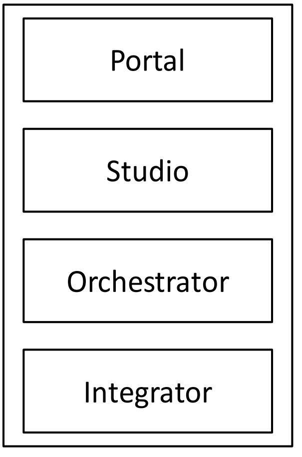


Figure 6.10: Four Layers of Cordys Product Stack

As shown in Figure 6.10, the Cordys product suite is a four-layer stack and several informants indicated that the allocation of work is based on where people have the requisite expertise and the time to work on a new area or requirement. For example, in Orchestrator, there was a particular vision item called XML/Web services Application Server – a single component – that required a specific expertise, which was available in the Netherlands. So, even though Orchestrator is owned by a team in Hyderabad, this particular component of Orchestrator was developed in the Netherlands. Similarly, most people in Cordys in the Netherlands have deep background in ERP software. So, by virtue of that, work that requires ERP knowledge and competencies in integration tends to be located in the Netherlands. Also, according to the Chief Technology Officer of Cordys, all work pertaining to the "lighthouse accounts", which requires working closely with customers, is being done in the Netherlands because of their proximity to the customers. But that might change in the future as the Cordys product footprint expands.

A Product Manager at Cordys (R&D) India explained in detail the entire modus operandi involved in the offshore R&D engagement:

The vision comes from the CTO. He provides the technical direction and we figure out how to implement the vision. For new areas, usually

> *the work goes to the team in the Netherlands. They do research and develop proof of concept, whereas those parts of the vision that can directly go to the product layers are handled and productized by us. Vision does not provide things in a black and while format – a lot of subsequent work is required. The members of the Product Management board work together to flush out details. Product marketing and program management also participate in the Product Management board.*
>
> *When a new or emergent requirement can be easily mapped to one of the product layers, then the product manager for that layer and the corresponding R&D team is assigned the responsibility. When it is not clear which layer a particular requirement belongs to, then a product manager is chosen and he works in a boundaryless manner with other teams. When we get something that has to be made part of the product offerings, then that particular set of requirements becomes a business requirement. For example, if we need to support WSDL for Web services, we know it is part of the Integrator product manager, and so he takes the responsibility for coordination across other layers to assess the overall product suite impact.*
>
> *To achieve this, we have product control sheet (PCS). So, for a business requirement, we list down the requirements as such and then from each team – across the product – we get effort estimation. It gives a view to the product management board, and priority is set by product marketing along with product management.*

6.4.4 Offshoring of R&D and Innovative Capability of Cordys

This section presents findings related to (a) generation of innovation by Cordys (R&D) India Center and (b) transfer of knowledge from Cordys (R&D) India to Cordys headquarters in the Netherlands.

6.4.4.1 Innovation Generation by Cordys India (R&D) Center

With a significant part of Cordys R&D located at its India R&D Center, it is natural to assume that the volume of innovations being produced by the offshore R&D center will be high. And, as a matter of fact, Cordys (R&D) India is considerably fueling the Company's innovative capability by generating innovations for its products and offerings. The interviews suggest that Cordys (R&D) India is supporting the Company's need for innovation by creating a pool of ideas on product architecture, functionality or features, implementing effective development processes, and designing and developing high performance, high quality software. However, Cordys (R&D) India represents an interesting case of what might be called "guided innovation". The ideas for innovations come from the senior and experienced architects in the Netherlands and the teams in India produce technological and architectural innovations in implementing the ideas and thus generate innovations.

Like many other offshore R&D centers, Cordys (R&D) India also has the disadvantage of distance from the customers and markets, especially because the ideas for innovations for the kind of enterprise software product Cordys makes usually come from the customers. However, an effective product management board and a close-knit community seem to offset some of the constraints that arise due to lack of proximity to markets. Not surprisingly, then, there have been instances when the India R&D has contributed innovations to Cordys' product suite.

Take, for example, the Orchestrator layer in the Cordys product stack, which was conceptualized and developed from scratch by Cordys (R&D) India. Orchestrator is already part of the deployed Cordys stack in the market. Orchestrator was the result of the initiatives taken by the teams in India, who benchmarked Cordys product suite with competitor offerings, did research, and proposed it to the Chief Technology Officer in the Netherlands, which eventually led to Orchestrator being incorporated in Cordys product suite. The Orchestrator layer has several market differentiating innovations contributed by Cordys (R&D) India. Talking about innovations in Orchestrator, a Product Manager at Cordys (R&D) India said:

> *An important feature in Orchestrator is the decision tables. We found that our competitors were offering this, and so we conceptualized it and proposed it, developed a PoC and later finally incorporated it in the product suite, for which there has been good customer acceptance and very positive analyst endorsement. It gave our product a market-edge, and the entire innovation cycle was handled in Hyderabad.*

The conversation with the Head of R&D at Cordys based in the Netherlands also revealed that the Flow Engine, an important feature in Orchestrator, was also the brainchild of the Cordys (R&D) India team.

Likewise, the Cordys (R&D) India has made innovative contributions to the other layers of the Cordys product suite. In a very candid interview, the Head of Product Management at Cordys, who is based in the Netherlands, talked about the contributions of Cordys (R&D) India:

> *The Portal layer was built from scratch at Hyderabad including conceptualization. The need for the Portal was known, but the rest was done by the Hyderabad team. Likewise, the Orchestrator was fully done in India – rule engine, process engine, data transformation*

> *engine, business objects, cache ... the entire thing. Also, the X-forms component and the Web tool kit product were mainly developed in Hyderabad, but the idea came from the Netherlands. The real work – design, development and productization happens in India.*

Even the Studio layer, which was originally conceptualized and developed in the Netherlands, has now been moved to India. Given this transfer in ownership, the India team now has the responsibility for future innovations in the Studio layer. The Integrator layer, which really forms the core of the Cordys product suite, has a huge legacy. The work on this layer was started in the Netherlands even before Cordys was formed. However, the India team developed backend application connectors for the other enterprise software packages like SAP – something which is crucial for market attractiveness of Cordys product suite.

> *Connectivity between the Cordys product and other systems is important, so initially we built connectors to ERP packages such as SAP. But that used to be a problem when the versions of ERP package would change. A team thought, why do we develop connectors and not connectivity? That led to a concept called the Cordys Connectivity Framework (CCF), with which the other companies could develop connectors. CCF will save a lot of dollars for customers.*

The Cordys (R&D) India team also designed and built the cluster management software for the SOA Grid in the Integrator layer of the Cordys product stack and introduced new services concepts like COBOC (Common Objects Business Cache).

In a vivid description of the business environment and R&D challenges, the Head of R&D at Cordys in the Netherlands, commented:

> *In the type of offshore work we do, there is a high-level of complexity, there is continuous change, and that requires agility, and that agility can come if there is ownership. For achieving a high degree of agility, the organizations have to become masters of their own destiny. You have to establish accountability for performance.*

Precisely to deal with such challenges and to be effective in product development tasks in line with market realities, the Cordys (R&D) India team also introduced a major process innovation within Cordys – the SCRUM agile development methodology. The SCRUM based product development methodology that the Cordys (R&D) India team has introduced allows frequent and small chunks of software code to be released in a way that evolving product requirements can be effectively addressed while ensuring good product quality.

What is enabling the Cordys (R&D) India to generate and introduce significant innovations for Cordys? Insights gathered from the interviews suggest that a combination of empowerment, trust, and the ability to take risks allow the Cordys (R&D) India team to take initiatives and produce valuable innovations. Also, over the years, the Cordys (R&D) India team has learnt the nuances of the enterprise software product development. In addition, the teams in India have had opportunities to occasionally interact with customers, which have provided them insights into customer needs and challenges. A Product Manager at Cordys (R&D) India described the environment that allows the India teams to innovate:

> *We have a lot of freedom to innovate and take risks. Of course, we have to have people who can utilize the freedom also. Of course, all of what we do is within a boundary, but within that there is a lot of space and trust.*

Amongst the ways Cordys (R&D) India is trying to foster a culture for innovation is a contest that challenges people with a specific theme and asks them to suggest ideas and solutions. For example, according to a Director at Cordys (R&D) India whom I interviewed, a recent theme for the contest was ‘usability’ which challenged people to suggest ideas for improving usability and publicly recognized those that provided valuable inputs. Incidentally, Cordys (R&D) India houses a unique usability lab to make the Cordys products more user-friendly.

Conversations with informants at Cordys concerning the pre-requisites for innovation, especially in the enterprise software products market, suggest that rich experience and exposure to customers are essential to understanding their needs and problems. Only when the customer needs and pain-points are understood, experience can be leveraged to generate innovations that will have marketplace impact. The teams in India realize that experience is something that cannot be replicated overnight. Also, customer input is so vital to the process of enterprise software product development that the need for the India teams to have regular and systematic customer interactions cannot be overemphasized should they be expected to continuously innovate for Cordys. Commenting on the effect of customer interactions on innovations contributed by the India R&D Center, the Head of Product Management at Cordys in the Netherlands observed:

> *The Hyderabad team had a lot of interactions with a customer for Orchestrator whereas it was much less for Portal, and you can see the difference in the quality of work. Software product development is an iterative process – during the cycle you need people who can use your product and validate it – it makes the product mature and the team learns.*

Also, it appears that hitherto the India R&D team was not really expected to generate innovations for Cordys, although the innovations that were generated through happenstance or local initiatives were duly acknowledged. Now, however, a change in expectation appears to be on the horizon, as is evident by the remarks of the Head of R&D at Cordys, who is based in the Netherlands:

> *I expect the India team to contribute towards innovation. I would say that we are in a transition process right now. So far, we have really not set any expectations on that front. If you don't expect, it won't happen.*

The Cordys (R&D) India teams are gradually acquiring deeper experience through their work on the Cordys product suite, by learning from their more experienced counterparts, as well as through the limited opportunities available for customer interactions. As the Cordys product footprint expands and the volume of business grows, the India R&D team is likely to have more and systematic opportunities to interface with customers. But even the current level of innovative contributions and the nature of work being performed by Cordys (R&D) India are noteworthy. Explaining the complexity and challenges involved in the work that is done by Cordys (R&D) India, a Product Architect at Hyderabad noted:

> *Even though we get directions from the Netherlands, most of the time we get a one-line query, a very high level gray idea like "I want to access it by a mobile device." A lot of functions and features have to be designed and developed which are technically quite involved.*

In the case of offshore R&D at Cordys, even though the seeds of innovation may be coming from the Netherlands, developing the ideas further and implementing them requires good technical proficiency. Indeed, designing an enterprise software product that is secure, scalable, compatible with other products, and delivers on the performance parameters is a non-trivial task. Also, creating products with a modular architecture that allows for addition of features in a flexible manner is no less challenging. Moreover, developing a product that works equally well on an open source product like Apache Web server, for which no documentation is available, adds to the challenges faced by the India R&D teams. The achievements and contributions of Cordys (R&D) India demonstrate that it has the ability to perform work at the cutting edge of technology and develop innovative products even when the technical standards involved are continuously changing. In a vivid description of the innovative contributions of the India R&D Center as well as its current limitations, the Chief Technology Officer of Cordys noted:

> *From a product point of view, I have seen many innovations [come out of Cordys (R&D) India]. Experienced people are really taking off.*

Orchestrator was done completely from India. From a conceptual point of view, I think it is one of the best implementations you can find in the globe, using BPML. Another good example is MDM (Master Data Management), which was completely developed in India. I think it is a very nice solution they have developed. But you have to be on top of it, help them and guide them, especially on the architecture side. Product management, engineers and architects [in India] are very eager and they spend a lot of time and energy on the product. The Hyderabad team also did a wonderful job on the Integrator, which was originally developed in the Netherlands and later handed over to Hyderabad.

But in terms of innovation, the Cordys (R&D) India team really does not have so much freedom. It has also to do with the situation – where we are coming from. Currently, the basic ideas come from the Netherlands, and we have to explain to them and guide them. I don't want to give an impression that it is like a father watching what the kid is doing, but it is ultimately all about experience. The Dutch team fills any holes in the Indian team by leveraging their experience. Also it depends on the individuals and their attitudes – those who are followers, you cannot expect much from them. This is a fact of life.

Currently, there is not much generation of ideas from India – they don't have relationship with innovative customers; the Dutch team has. They [the Dutch team] also have experience, but in five years time the folks in India will have learnt all the tricks – it is just a matter of time. Innovation ideas come from customers but how you implement technologically could be innovative. In Cordys, we have grouped together many innovative ideas to create a compelling product but innovative assembly is also important and has much more value.

6.4.4.2 Knowledge Transfer from Cordys (R&D) India to Cordys Headquarters

With 70% of R&D resources located at Cordys' offshore R&D center in India, the dimension of learning and knowledge integration assumes significance. Even the senior managers recognize this to be a matter of great importance, as is suggested by the following remarks of the Managing Director of Cordys (R&D) India:

We have to do a much better job. Knowledge is put into products – into architecture, functionality and features, but not much is coming out for others. Knowledge on how the products work, how a product is to supported, etc. Knowledge extraction is a big challenge.

While the R&D engineers at the India Center have learnt a great deal from their senior and experienced counterparts in the Netherlands, the situation pertaining to reverse knowledge transfer is not yet very pronounced, especially from the perspective of criticality of technological knowledge. The two locations closely interact on a day-to-day basis through phone calls and Web-based systems, exchanging information and sharing perspectives. Technology tools like MSN and WebEx are also extensively used for communication and knowledge exchange. There are also periodic face-to-face meetings as well as visits by team members to the other site, which facilitate interactions and knowledge exchange. All project reporting and status update is done via a Web-based system and is accessible to everyone. Cordys managers believe that this approach to reporting builds openness, trust, transparency and accountability. Also, extensive documentation is an integral part of the output in each phase of the R&D cycle, which allows for codification of knowledge and makes it accessible to all. But interaction between the team members from two locations seems to be the primary mechanism for learning and knowledge integration.

The major initiative within Cordys to promote experiential learning and knowledge capture is Cordys Developer Network – a collaborative forum for Cordys employees, customers and partners, which facilitates experience and knowledge exchange. The Cordys Developer Networks was built by Cordys (R&D) India. The India R&D team also came with the idea of “knowledge containers” which is seeks to capture knowledge and learning pertaining to the various components of the Cordys product stack. The India team also develops an F.A.Q. with each new release of components, which helps people understand new features and their capability. Both the Cordys Developer Network and the knowledge containers are aimed at unleashing and capturing tacit knowledge, although the managers at Cordys recognize that there is no substitute for interactions as far as tacit knowledge sharing is concerned.

Initiative like the SRCUM development process, which was evaluated, piloted and adopted by Cordys (R&D) India have indeed brought new learning to the Cordys team members in the Netherlands. The managers at Cordys H.Q. in the Netherlands believe that there is good distribution of complementary knowledge across the two locations but they are also concerned about high attrition rate at Cordys (R&D) India, which results in knowledge loss.

6.4.5 Offshoring of R&D and Cordys’ Organizational Flexibility

Cordys has systematically leveraged its offshore R&D center in India to derive flexibility and augment its competitiveness in several ways. First of all, Cordys significantly sources the needed operational flexibility from its R&D Center in India. The ability to quickly hire, train and deploy people in India allows it to smoothly respond to the business growth challenges at a low cost. The resource pool in India is young, adaptable and proficient in English language, which allows Cordys to serve customers in many different locations. According to managers in the Netherlands, people in India demonstrate a high degree of commitment to their work and are flexible in terms of working hours. Remarking on how the India R&D center contributes to Cordys' need for flexibility, its Managing Director said:

> *Flexibility is a distinguishing element of India. People are flexible and mobile, which helps in deployment of products and customer support. People stretch themselves for extended duration in order to deliver on project objectives. The flexibility comes from the cultural diversity in India, which makes people adaptive and open to something different.*

Cordys managers in Netherlands also believe that the teams in India are very quick at new technology assimilation. According to them, there is an eagerness to learn among the team members in India, and this helps the Company operate at the edge of the technology. However, the managers on both the sides acknowledge that the India has more breadth spanning various technology areas, whereas the team in the Netherlands has solid depth in certain areas. The breadth of competencies at the R&D center in India allows Cordys to effectively respond to multitude of demands that come from its business environment, but at the same time it also sustains the dependency on the Dutch team. There is also a certain cultural flexibility at the India R&D center, which benefits Cordys by way of rapid execution of its R&D objectives as testified the following statement of the Company's Chief Technology Officer:

> *In India, when a decision is taken, either by the local management or in conjunction with the Dutch team, it will be executed. In the Dutch operations, it takes a long time because here people tend to argue forever.*

But he was also quick to add that there is a flipside to such a work culture, which gets tuned to follow and has no mentality to challenge or push back.

Explaining the business environment at Cordys and the need for flexibility, the Head of Product Management based in the Netherlands shared his perspectives on how Cordys (R&D) India serves as a source of flexibility for Cordys:

> *We operate at the edge of technology in a very dynamic environment. The market speed is a reality and we have to be fast; we have to quickly understand gaps in competitors' products and innovate fast. Technologies and standards are continuously evolving. The India team is quick to assimilate new technologies. They are also adaptable to work on new technologies. India has a lot of breadth whereas the team*

> *here has immense depth. You need breadth for speed and market sweep.*
>
> *In India, we have the ability to quickly ramp-up people, which helps with our growth objectives because of the scale. We are also able to re-organize and re-group faster.*

Cordys leverages the qualified, low cost bandwidth available in India to try out new ideas, develop prototypes, and carry out experimentations. The young, energetic and eager talent pool in India obviously serves this purpose well. The India R&D team has also made a significant contribution to Cordys by introducing an agile product development process (SCRUM), which gives flexibility to Cordys by way of aligning its product development activities with market dynamics.

6.4.6 Impressions from Cordys' Offshore R&D Engagement

The Cordys (R&D) India represents a unique case of offshore R&D organization that generates high leverage for Cordys. With 75% of R&D resources based in India and a neat division of work between the two locations, Cordys is certainly strategically harnessing its India center for its competitiveness. The case of Cordys suggests a model of offshore R&D that leverages "guided innovation", which involves providing vision and direction to a technical resource pool, given them ownership of some parts or products from a technical perspectives across the life cycle, and challenge them to unleash innovative outputs. In such a model, the offshore R&D team is locked into the business plan and strategy of the company, so their boundary of operation is defined.

The allocation of work to the offshore R&D teams is based on a simple classification of work – pre-development and development. By and large, all the development activities related to all the stacks of the Cordys product suite are carried out by Cordys (R&D) India, although it appears that at times the allocation of work is based on determination of the complexity involved.

The case of offshore R&D at Cordys also brings forth an important point: since Cordys has made a deliberate decision to locate a significant portion of its R&D in India, there is a conscious effort to strategically leverage offshore R&D. This is reflected in the attitude of its managers in the Netherlands, who are more driven by the opportunities than affected by the constraints. Commenting on the challenges of offshore R&D, the Netherlands based Head of R&D at Cordys remarked:

> *When people talk about offshoring, they talk about cultural differences and that it makes it extremely difficult. Having worked with India for 9 years, what I have seen is that the commonalities are much more than the differences because of culture. So, I would suggest that don't put*

> *culture on your list of top things to solve because I feel the issue is much less really. So, our design principle is, is there a cultural difference? Yes. Is there an issue? No, because you can learn from each other.*

The interviews with the managers at Cordys suggest that the low cost but highly capable resource pool that also demonstrates short learning curve, has allowed the firm to expand its innovation capacity and enhance innovation capability. Besides speed to market, a significant offshore R&D presence has also enabled Cordys to reduce its product TCO and thus gain more flexibility in pricing its products and offerings. Cordys (R&D) India also contributes significant operational and structural flexibility to its parent company by way of quick ramp-up of R&D teams in line with growth plans as well as through its ability to easily re-organize and re-group people. Cultural flexibility, which seems to be typical of Indian resource pool combined with their ability to assimilate new technologies lends further flexibility to Cordys and influenced its competitiveness.

Notwithstanding the current limitations and constraints primarily stemming from a lack of customer interactions, the Cordys case demonstrates that good teamwork, trust, empowerment, vision and information flow can enhance the contributions of an offshore R&D team. In Cordys, a capable and motivated offshore R&D team is fueling product competitiveness by delivering key market requirements on time and with quality. The low resource cost and quality focus, which leads to a reduced cost of quality, leads to a higher profitability over the product lifecycle for Cordys. Clearly, Jan Baan's vision combined with the operating model has resulted in more financial viability for Cordys as the company is able to derive maximum leverage through cost arbitrage and talent scale. Perhaps, a systematic thrust on harnessing the distributed knowledge and integrating it into the corporate memory will augment Cordys' competitiveness in the long run.

6.5 CASE STUDY V: GLOBETRONIX

This case study is about the offshore R&D engagement between Globetronix—a consumer electronics giant, and its software R&D center in India.

6.5.1 Background and Context

Globetronix, headquartered in Europe, is a consumer electronics giant with market presence worldwide. In 2006, Globetronix posted annual revenue in excess of €8 billion and employed more than 100000 people worldwide. The company produces and sells a range of consumer electronics products such as television sets (including high-definition televisions), home theater systems, wireless audio systems for home entertainment, DVDs, VoIP cordless digital phones, IP TV set-top boxes, universal remote controls, digital displays, mobile phones, and peripherals and accessories such as headphones. Globetronix has a long tradition of cutting edge research and development and has several breakthrough inventions to its credit.

Since continuous innovation is critical for its sustained market competitiveness, Globetronix invests considerable amount of capital on R&D. The R&D activities at Globetronix are spread over its operating business divisions as well as a centralized, Corporate R&D group. The operating divisions perform R&D that is directly supportive of their product roadmaps, whereas Corporate R&D focuses on competencies and technologies that have longer-term orientation. However, in recent years, the emphasis at Globetronix has been on performing more and more end-user-oriented R&D aimed at short-term commercial prospects. In 2006, Globetronix spent more than €350 million on research and development although the R&D intensity over the last three years has declined due to tightening cost controls and increasing reliance on outsourcing.

Globetronix operates in a fast-paced, volatile and price-sensitive market. The pace of introduction of new products, development of new technologies and standards, and increasing consumer expectations make Globetronix's business environment highly cut throat. The consumer electronics industry also experiences seasonality. The dynamics of the consumer electronics industry are changing rapidly. With the shift from analog to digital, increased broadband penetration offering a variety of on-demand services, as well as an expansion of digital 'eco-systems' – the seamless sharing of content between devices – consumers now have unprecedented access to a wide selection of services on multiple devices, whether at home or on the move. Coupled with the growing convergence, there are a number of highly competitive entrants in the consumer electronics industry that include new Asian brands as well as established IT players offering PC-based devices, which provide alternative access to traditional consumer electronics services in the living room.

The prognosis for Globetronix's competitiveness, therefore, is clear: rapidly develop and introduce compelling products ahead of its competitors with high quality and competitive pricing, and have the flexibility to respond to market demands effectively. In response to the challenge posed by a highly dynamic and competitive business environment, Globetronix has been focusing on reducing its operating capital and organizational costs in order to drive sustainable performance and value creation. In 2006, Globetronix outsourced as much as 70% of its value creation activities. Globetronix's strategy is to develop new, high-end consumer electronics products and be the first to market while capitalizing on the opportunities that are unfolding due to a growing convergence of computing, electronics, and communications. Thus, in addition to differentiating features, product quality and reliability are crucial for success and speed to market is of paramount importance.

Over the years, software has become very crucial for all Globetronix products and often determines their market competitiveness. In 1996, Globetronix established a wholly-owned offshore software R&D center in India, primarily to fulfill the growing need for software capability in its products at low cost structures. The software R&D center in India has emerged as a software competence center for all business divisions of Globetronix. During October 2005 and March 2006, I visited Globetronix's offshore R&D center located in India and one of its R&D centers in Europe, and interviewed several people to understand how the offshore R&D center was being leveraged by Globetronix for innovative capability and organizational flexibility. Table 6.6 provides details of the interviews conducted.

Table 6.6: Details of the Interviews Conducted at Globetronix

#	Position/Role	Location	Date of Interview	Mode of Interview
1	Program Manager	India	November 29, 2005	Face-to-Face
2	Technical Architect	India	November 29, 2005	Face-to-Face
3	Department Manager	India	November 29, 2005	Face-to-Face
4	R&D Manager	India	November 29, 2005	Face-to-Face
5	Technical Architect	India	November 29, 2005	Face-to-Face
6	Managing Director Globetronix India R&D	India	October 28, 2005	Face-to-Face
7	R&D Program Manager Home Entertainment	Singapore	January 26, 2006	Telephone
8	R&D Program Manager Home Entertainment	Europe	March 17, 2006	Face-to-Face
9	Product Architect Home Entertainment	Europe	March 17, 2006	Face-to-Face

6.5.2 Offshoring of R&D by Globetronix

Globetronix India R&D Center was established as a wholly-owned subsidiary of Globetronix in 1996. The Center was set-up with the vision to eventually become a high-impact value chain partner for the various product divisions of Globetronix and cater to their growing software R&D needs. The Center has a wide range of software competencies and is assessed at the Level 5 of the Capability Maturity Model (CMM). The interviews indicate that the primary motivation for setting up Globetronix was to access large pool of software talent at a low cost, which seems to be in line with Globetronix' strategic directions. On one hand, software has increasingly become a crucial factor for Globetronix' products and on the other hand, the need to control costs, including R&D costs, was becoming paramount for profitability. Establishment of the R&D center in India has allowed Globetronix to leverage high quality, low cost software talent available in large scale in India. Globetronix's India R&D Center houses currently nearly 30% of the total software R&D resources within the company. Describing the nature of R&D activities at Globetronix's Managing Director, a European national, noted:

> *We are here for R&D, primarily for 'D' – for resources, because we could not get the resources in Europe. Cost in an important driver. We are currently an offshore R&D center and primarily engaged in product development. But, eventually we want to build a full-fledged R&D lab. We are ten years old, and it will take another five years to mature.*

The Center's contributions have evolved over the years from initially being a resource center to a development center, and now to a recognized software competence center. The envisioned evolution trajectory of Globetronix's India R&D Center is to eventually become an integral partner for the growth of the various Globetronix products divisions as well as a source of high-impact innovations for the company. Since the time of its establishment in 1996, when the first R&D project started with a team of 15 people, Globetronix's R&D Center in India had grown to a size of more than 600 R&D engineers as of November 2005. The center currently performs software R&D activities for all the major products of Globetronix, including television sets (picture tune TV, LCD TV and Plasma TV), a range of audio products, DVD players and DVD recorders, home theaters, and a variety of mobile infotainment products such as video and audio juke box, portable entertainment devices, and universal remote controls. For many of the products, the entire software R&D is now done at Globetronix. The center, however, does not own any product-market mandate and also, according to its managing director and managers at other locations, the software R&D skills at the India center are not unique.

6.5.3 Organization and Management of Offshore R&D by Globetronix

This section presents an account of the organizational and management processes associated with Globetronix's offshore R&D engagement with its R&D subsidiary in India, covering structural characteristics, relational characteristics, and R&D task allocation practices.

6.5.3.1 Structural Characteristics

Globetronix India R&D Center is positioned as a software competence center and operates as software R&D partner to the various Globetronix product divisions. The Center does not have an allocated budget of its own; it's a cost center and is funded by the various Globetronix product divisions. Generally, the R&D activities carried out at Globetronix's India R&D Center are allocated to it by the various Globetronix product divisions depending on their needs as well as their assessment of the competencies available in India. Senior managers from the India R&D center also extensively network with executives at Globetronix's product divisions headquartered overseas, and engage in internal business development to generate work for the Center. The India R&D Center also performs cutting-edge, exploratory software R&D projects for new technology development funded by Corporate R&D. Usually, the allocation of R&D work to Globetronix's India R&D enter is based on the intent to develop certain software competencies and, therefore, is driven by a roadmap.

Figure 6.11 shows the governance structure for the offshore R&D engagement between the various Globetronix product divisions and the India R&D Center. Typically, each division at Globetronix has several business line clusters; for example, DVD Recorders is a business line within the home entertainment division. The teams at Globetronix India R&D Center work with business lines which are headquartered in various parts of the world and collaborate with R&D organizations in Europe and Silicon Valley in the U.S. The business lines determine the scope of R&D activities to be performed at Globetronix India R&D Center and also provide funding.

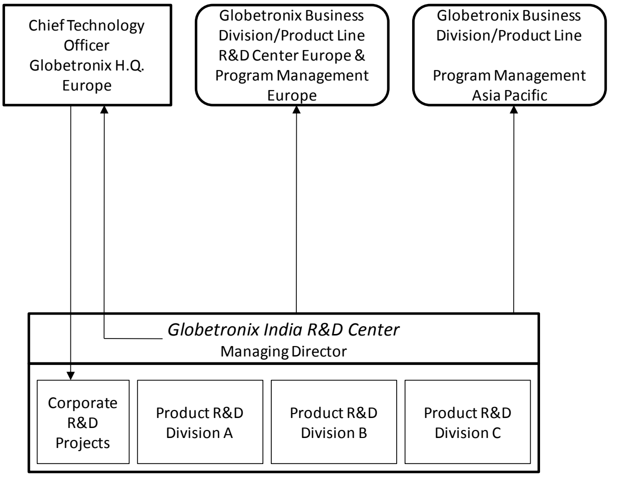


Figure 6.11: Organization and Governance of Offshore R&D at Globetronix

For specific product R&D programs, the concerned product managers decide on the product contents and features, whereas the product development is coordinated by program managers. Typically, both product management and program management are located where the business line is headquartered. All the R&D groups at Globetronix's India R&D Center are supported by the Managing Director, who reports to the Chief Technology Officer of Globetronix.

6.5.3.2 Relational Characteristics

The dynamics of the relationship between Globetronix India R&D Center and its business line partners from various divisions headquartered overseas (USA/Europe/Asia) vary but overall resemble a principal – agent structure. There are three aspects that influence the relationship dynamics between Globetronix India R&D Center and its business line partners. First, within most of the Globetronix divisions, there is heavy emphasis on cost management and an increasing preference for outsourcing. Moreover, Globetronix's R&D budget has been shrinking over the years, implying a need for greater efficiency and effectiveness in the organization and management of R&D. Naturally this causes some insecurity among Globetronix's R&D engineers in Europe. Moreover, all the groups at Globetronix India R&D Center are dependent on funds allocated to them by their respective business lines, which implies that they are not in a position to exercise choice on the kind of R&D work they do. In addition, there is a corporate mandate within Globetronix to locate and leverage software competencies at the India R&D Center. Consequently, all headcount growth and competency development for Globetronix' software capability needs generally happens in India. However, this does not unfold without any resistance at the operating level. In fact, many consider this to be a constraint imposed on them by the corporation, as is suggested by the following remarks of an R&D Program Manager from the home entertainment division based in Singapore:

> *For us, it is like a constraint driven by the corporate headquarters. Even though I am responsible for the program's success, I cannot really evaluate Globetronix India R&D Center. I cannot say whether the India Center makes our product lines competitive – it's not a competitive selection.*

The relationship structure varies from group to group – some are tightly controlled, whereas some are loosely managed. Even though the relationships have evolved and matured, every relationship between the business lines and their corresponding R&D groups at Globetronix India R&D Center shows signs of strain. A Department Manager at Globetronix India R&D Center observed:

> *In the TV area, there is a very tight control from Europe. There is too much micro-management from our partners. We need some degree of autonomy and space for our own thinking. Micro-management arises in the form of wanting to know the people on the project. The partners have opinions on the people. Typically, the western European culture is quite outspoken. People tend to speak and express themselves pretty well, and if they see people who are not in*

the same category or paradigm, they think the person is not good enough.

However, by and large the relationship between the R&D groups in India and their business group/line partners at other locations has evolved and matured over a period of time. Now there is a greater degree of inclusivity for the Globetronix India R&D Center teams and the relationship is more participatory as suggested by a Senior Technical Architect in India:

Earlier we used to view the world through a filter. Earlier, we were involved when a platform decision was made. Now, we are involved in platform definition and selection.

6.5.3.3 R&D Task Allocation

The interview findings indicate that 'core versus non-core' and 'risk management' are two main factors that shape the criteria Globetronix business groups use in allocating work to the R&D Center in India. However, over a period of time it has become a norm to organize more and more software R&D work in India. This is partly a due to the corporate mandate and partly a result of growing trust and confidence in the capability of the teams in India. Consider, for example, the case of TV, which was the first business line to start work at Globetronix India R&D Center back in 1996. Tracing the evolution of the TV R&D activities, a Program Manager Globetronix's India R&D Center commented:

The teams in India were initially involved in user interface development and testing, and delivered their outputs to an R&D Center in Europe. The core platforms were developed in Europe. The integration testing, alpha testing and beta testing were also performed there. Initially, we sent people to Europe for 6 months to 2 years for joint projects as well as for training. These people participated in platform development, architecture development, and systems integration. These people acquired in-depth understanding of the product and other technical issues. And when these people came back, the partners had the confidence that they could work with Globetronix India R&D Center. Now, the platform teams, user interface teams, and application teams are all in India. System integration and alpha testing also happens here. Globetronix India R&D Center also supports the product groups to get certifications done, including for audio and picture quality. Now, we take care of the entire product from a software point of view.

A close examination of the work allocation patterns across various R&D groups at the India R&D Center suggests some commonality. In most cases, first, some work that was non-core and not market critical was allocated to Globetronix India R&D Center. As the teams in India slowly built and demonstrated their competencies, higher level/complexity of R&D work was assigned to them. Also, when a new software competency was involved, or when the products needed to migrate to a new technology, the India R&D center was called upon to perform such work. For example, when Microsoft's .NET technology arrived on the scene, Globetronix's India R&D Center was automatically assigned several competency development projects to migrate/support Globetronix products to/on .NET environment.

Over a period of time, as the R&D groups in India gained the confidence of their partners, they have become an integral part of product R&D roadmapping process, particularly from the software competencies point of view. Also, enforcement of the directive from the Corporate that most software work should be done in India has helped grow the volume of software R&D at Globetronix India R&D Center. Today for many of the Globetronix products, all the software R&D is performed by the R&D Center in India. For example, in the case of DVD Recorders, the program management in based in Singapore and all software R&D, except the front-end software, is done in India. Explaining the current approach to work allocation a Department Manager at Globetronix India R&D Center noted:

> *Work allocation is based on software competencies. We use layered stack architecture as the basis for work allocation. Typically, the stack architectures in our products have four layers – platform, middleware, applications and UI. In most cases, the platform work is done by other locations in Europe or the U.S., whereas we are responsible for all the other three layers. Cost is also a criterion for work allocation, especially with shrinking budgets. So, if you can move things, then you can focus on higher value added jobs. Right now the positioning is that partners will concentrate on innovation space and we focus on execution space.*

It also appears that the approach to work allocation within Globetronix seeks to minimize the number of interfaces in an R&D program. Citing the case of the DVD product, the Managing Director of Globetronix India R&D Center said:

> *For DVD, we had teams in many locations in Europe and a growing team in India. But, that won't work because it would lead to more interfaces. Less interfaces means less risk of failure. We could not have managed it. So, we ramped up fast, placed people overseas, and developed the entire software in India.*

Illuminating on the work allocation criteria, a Senior Technical Lead based in India provided an additional and interesting perspective on how learning curve influences the work allocation:

> *Usually, the core platforms for most of the products come from our R&D organizations in Europe. The roots of most of the products are there in Europe. Application and UI layers undergo frequent changes based on market needs. Usually, the first-of-its-kind work happens in Europe and when it stabilizes, it is moved to other locations. Time to market is very critical. Cost of the products is going down, so any investment in the learning curve will actually drive the product cost up. That's why the Product Management in Singapore feels more comfortable with the R&D labs in Europe than India. Product Management thinks that by moving the job to India the product introduction in the market will be delayed because of the learning curve.*

6.5.4 Offshoring of R&D and Innovative Capability of Globetronix

This section presents findings related to (a) generation of innovation by Globetronix India R&D Center and (b) transfer of knowledge from Globetronix India R&D Center to the company's R&D labs in Europe.

6.5.4.1 Innovation Generation by Globetronix India R&D Center

Globetronix's India R&D Center does not have its own product–market mandate. Instead, it feeds in software R&D capability into the products of the various business divisions that choose to collaborate with it. Different business divisions/lines determine the scope of software R&D that they want Globetronix India R&D Center to perform for them and accordingly provide funding. Since the involvement of Globetronix's India R&D Center is based on work assigned to it by the business divisions/lines, which are also often time bound, the R&D teams in India have to really innovate within a boundary. Interviews indicate that the innovations produced by Globetronix's India R&D Center are largely incremental and technological in nature.

Software is increasingly seen as the differentiator for Globetronix products and given that a significant volume of software is contributed by the R&D Center in India, its ability to innovate for Globetronix assumes importance. However, having to operate in a boundary, as discussed above, seems to determine the innovation span for the teams at Globetronix India R&D Center. Moreover, since the R&D teams in India are away from the customers and markets, it has a bearing on their ability to innovate. So, generally, their expertise is called upon for keeping pace with changing technology, incorporating them into products, and transforming products with new technology. However in spite of having to work within a time-boxed boundary, the teams at

Globetronix India R&D Center have made some significant innovative contributions. Even though such contributions to products and development processes might be incremental in nature, they seem to be vital for Globetronix.

Take, for example, the case of Globetronix' DVD product, the entire software stack for which was designed and developed by Globetronix India R&D Center, including the user interface. Earlier, Globetronix India R&D Center did the same for VCR. According to the Managing Director of Globetronix India R&D Center:

> *We could not have launched DVDs without the India R&D Center. For consumer electronics, speed is very high. You invent a product in the U.S. or Europe, and very soon a Chinese company can beat the crap out of you, sometimes using our own chips because they are available to everyone. So, you need to stay ahead of the pack. We have to bring innovation from Europe to China for quick manufacture for the global market. If you look at it from that perspective, our ability to staff up huge software R&D teams quickly is our strength. For DVD, we staffed up a team of 200 people in one year's time, pretty competent in execution, adding new features quickly. However, I have no way of measuring our innovative output or contribution.*

Likewise, the DVD recorder R&D work, which is distributed across Europe, India and Singapore, is technically quite challenging as it involves development of technology for hard disk recording. For Globetronix DVD Recorder product, the core platform comes from Europe, the middleware, application and user interface layers are contributed by India, and the integration testing is done in Singapore. Indeed, in a collaborative environment, where geographically distributed R&D teams are contributing to development of a product, isolating the innovative contributions of one particular location might be a constraint. Yet, contributing three layers of a four-layer software stack for a new product is a significant innovation contribution by all means. Likewise, the R&D Center in India contributed another major innovation for Globetronix in the area of home networking, as described by a Senior Technical Architect in India:

> *One radical innovation facilitated our entry into the home networking segment. The home networking field is still in its embryonic stage. It opened a whole new segment for Globetronix. We started the product work here, developed it, and made a release from here. Based on the limited success, we worked further. We did not have background in this area but now 7-8 products are in the works under the home networking product portfolio. The product*

> *management was not located in India and production was outsourced to Taiwan. It was the first plug-and-play universal audio video receiver in the world combined with Wi-Fi. We also received a letter of appreciation from UnPP[12] for this work.*

Interviews with the people in India revealed other instances of innovations generated by Globetronix's India R&D Center. Consider, for example, the case of the Media Server, which was designed and developed by an R&D group in India. A Senior Technical Architect at Globetronix's India R&D Center, who had been involved in developing the media server product, shared details about the innovation and how it came about:

> *Earlier we had worked on a similar product called Media Center, for which we had done implementation work. So, the idea had been there for a while. What we did was, we took two platforms – one receiver platform and the other one a DVD recorder with hard disk. We showed that we have a product that can pick content from PC or the Internet and bring to a consumer electronics device. We linked the two platforms [both are not open platforms]. In Media Server, any remote client can access contents from the hard disk and play elsewhere. We took the initiative for the Media Server, defined requirements, and demonstrated a prototype, which was then accepted. Based on that, Globetronix has decided to develop a full product.*

Good user interfaces are very crucial for success of consumer electronics products, and engineers at Globetronix India R&D Center have contributed by modifying a four-way user interface to a two-way user interface. Similarly, the India R&D Center has deep involvement with Globetronix's personal infotainment product R&D programs and is contributing new software based innovations to the product portfolio and managing significant global projects.

Transitioning from a competence center that co-develops products into an innovation center that powers the company's innovative capability is high on the agenda of Globetronix India R&D Center. Currently, the Center measures its innovation contribution in terms of the number of product features proposed versus accepted by its partners, and the percentage of the software R&D it contributes for various products. Also, Globetronix's India R&D Center systematically leverages software reuse and exploits the time zone differences between Europe, USA and India to accelerate speed of innovation. However, even though patents are considered as an important measure

[12] UnPP is standardization body. UnPP stands for Universal Plug-and-Play.

for innovation within Globetronix, the number of patents filed by its India R&D center is abysmal. The R&D teams in India realize that they need to step up their innovative contributions, particularly those that drive marketplace performance. A Program Manager at Globetronix India R&D Center, with whom I spoke at length, expressed that there is a considerable room for improving the level of contributions as far as innovation is concerned:

> *We have contributed in the area of standards but in terms of new concept development, product creation and the like, I don't think we have done anything yet. We have developed some ideas, like user manual on TV, etc., but we have not done any major technological innovation yet. Neither have we done any market differentiating product features yet. There are many process innovations but it impacts in a very subtle way. Many of the process innovations came about due to our need to be effective because we were at the end of the business chain. Later, of course, these processes like multi-site requirements gathering became a global process.*

Similarly, another Department Manager at Globetronix India R&D Center observed:

> *Our innovation contributions are more incremental – not earth shaking; more of product improvements and new features.*

Since the resource to innovative output ratio at Globetronix India R&D Center seemed somewhat low, I probed on this aspect further and asked many informants as to what was the reason for the low volume and quality of innovations. In response, I received several insightful, and sometimes contradictory, perspectives. A Project Manger associated with TV related R&D activities at Globetronix India R&D Center remarked:

> *Why no big innovation? Because TV as a product has not fundamentally changed except some evolution like analog to digital and connectivity. But, of course, there have been major innovations on picture quality. But, we are not part of the chain for this. Sometimes we have good technical proposals but often we fail to show the business or commercial side of it. The scope for innovation is there but that requires figuring out the right use case.*

A Senior Technical Architect in India, who provided a detailed account of the offshore R&D engagement between the various Globetronix divisions and its India R&D Center, attributed the problem of low volume and impact of innovations to the operating model of Globetronix India R&D Center:

> *The lack of innovation is due to the model. We get budget for certain person years and for pre-defined activities. We are continuously attuned to a development–release– development kind of mindset. It is difficult to focus on new idea generation; we can only focus on improvements and extensions to the product. For achieving breakthroughs, we have to have the ability to take risks. We are not able to produce innovations when we are asked to work within boundary – we need our own space. There is not much scope for implementation level innovation because we would use pre-existing software stacks for which we need to follow some rules.*

The same informant also felt that the role of leadership makes a difference to how people work and what kind of outputs they produce. He observed:

> *People just believe what they are told. So, if we told them that you are capable only of implementing, they would just believe that. But I have found that whenever the target was set high, people produced higher level of results. People respond to challenge when they are given a stretch goal. This requires someone appropriate to lead, understand, and set goals.*

My conversations with mangers and technical architects on innovation in offshore R&D also surfaced another dynamic. In a one-on-one interview, the R&D Program Manager for one of the product lines of Globetronix's home entertainment business based in Singapore, observed:

> *Quality is one area we have constantly struggled with. The India R&D center being an internal center, we don't have a contractual agreement for performance. For Globetronix products, given a choice, I would prefer to go to Taiwan or China because SoC*[13] *is the direction of technology evolution.*

And, interestingly, a Program Manager at Globetronix's India R&D Center, who is looking after development activities for the same business division, echoed the above remarks in his conversations with me:

> *We are now facing high field call rates, almost twice of the average. So, there is a room for quality improvement. This is due to lack of experience and domain knowledge at our end.*

---

[13] SoC is commonly used abbreviation for System-on-Chips.

Even the corporate R&D projects done at Globetronix R&D Center in India have not yet produced any significant innovations for Globetronix.

6.5.4.2 Knowledge Transfer from Globetronix India R&D Center to R&D Labs at Globetronix Headquarters

With as many as 30% of Globetronix's total software R&D resources located at its India R&D Center, naturally a substantial amount of learning and new knowledge creation happens in India. Therefore, assimilation of learning and integration of new knowledge into the larger organization assumes importance for Globetronix's innovative capability. Such reverse learning and knowledge integration is particularly important because of the increasing role of software for the competitiveness of Globetronix products. In order to facilitate learning and knowledge integration, there are several formal and informal mechanisms in place at Globetronix. These include extensive electronic infrastructures like Intranet and blogs, product architecture councils, technical newsletters, etc. In compliance with its high maturity quality management system, all R&D work products are accompanied by extensive documentation, leading to codification of knowledge. Moreover, knowledge of new software technologies is also integrated into the products that Globetronix India R&D works on.

Teams at Globetronix India R&D Center also carry out feasibility studies and develop new feature proposals, which result in codification of ideas, new learning and knowledge. However, in addition to formal mechanisms, frequent exchange of people from across locations and regular telephonic conversations among R&D engineers from across locations provide informal ways of interaction, learning and knowledge exchange.

In terms of learning and knowledge integration, it is widely believed within Globetronix that the India R&D Center organizational model presents an advantage since it promotes exploitation of cross-group synergy by virtue of the fact software R&D groups for many products are co-located. In investigating the extent and type of learning and knowledge integration from the India R&D Center into Globetronix at large, it appears that it is mostly software engineering and technology related learning and knowledge that gets exchanged. What is noteworthy in this context is that most of the R&D for various products and product platforms that the India team performs has been inherited from other R&D locations of Globetronix that have existed since many years. As a result, a lot of knowledge already resides with the R&D teams at these locations in Europe and the U.S. The differential knowledge generated in India that may be new to R&D engineers at other locations usually pertains to new software technologies, and it appears that such knowledge, while vital for Globetronix as a corporation, does not appeal to most R&D engineers at the company's other R&D

locations. The interviews with managers at Globetronix R&D locations in Europe and the U.S. indicate an absence of interest and attitude in learning from teams in India, which, it seems, stems from an assumption that the India Center does not have much to offer by way of learning and new knowledge.

6.5.5 Offshoring of R&D and Organizational Flexibility of Globetronix

Examination of organizational flexibility in the context of offshoring of R&D at Globetronix's suggests that the India R&D Center serves as a significant source of operational flexibility. Due to the availability of vast, low-cost talent pool available in India, the center can grow quickly and also ramp-up (or down) staff on R&D projects in accordance with emergent priorities. Due to its large pool of 600 software R&D resources, the India center can quickly provide a range of software capabilities to the various product groups within Globetronix. Also, interestingly, 20% of the total R&D resources at the India R&D center are hired on contract to maintain flexibility, perhaps in accordance with the company-wide thrust on outsourcing to reduce fixed costs. According to the Managing Director of the Globetronix India R&D Center, contacted resource pool allows for effective handling of business uncertainties.

The interviews suggest that the ability to quickly ramp-up and ramp-down resources R&D on projects offers operational flexibility that Globetronix India R&D Center's partners tremendously value. For example, when the responsibility for the entire DVD software development was being moved to India, the India R&D Center ramped-up a team of 200 R&D engineers in about a year's time. Such an operational flexibility also releases bandwidth at other locations and allows R&D engineers there to focus on other priorities or competencies.

Flexibility is a competitive necessity for Globetronix because consumer electronics is a highly dynamic sector, where the pace of change is very fast and competition cut throat. Interviews with Globetronix managers suggest that for Globetronix both strategic and operational flexibility is important. Consider the following statement of the Managing Director of Globetronix India R&D Center:

> *It is interesting, by the way, to look at Globetronix from a flexibility point of view. We did not realize that the open innovation model was taking over as we struggled to make the total vertical value chain work. So, you need to be flexible in R&D and respond to situation effectively. We realized the importance of this for consumer electronics. Customers, for example, don't want a DVD player to only play DVD but all other content on CDs. In this space, the value of partnership is very crucial. Because of the fast cycle, we can be first to market*

Interestingly, it appears that certain cultural factors in India also serve as source of flexibility for Globetronix. Managers in the U.S. and Europe recognize that the young resource pool in India is quick to learn and adaptive in dealing with new project requirements. According to several managers, engineers in India stretch themselves for the successful accomplishment of project goals and also demonstrate flexibility in learning and adopting new technologies. There is also a common belief within Globetronix that due to their heritage people at other R&D locations exhibit inertia towards technological change but the India center helps overcome the inertia by bringing in new, state-of-the-art software technology skills. For example, for Globetronix, the transition from analog to digital TV was met with several mind blocks due to affinity of the engineers in Europe with familiar technologies and pride of prior work. In other words, their heritage was leading to inertia. In such situations, an organization like Globetronix India R&D Center with no heritage can provide the needed flexibility to embrace new technologies.

6.5.6 Impressions from Globetronix's Offshore R&D Engagement

Software is increasingly becoming important for Globetronix products, and in this context, its India R&D center is adding considerable value through its software R&D capability. On one hand, the offshore R&D center provides a large scale and variety of software skills, which not only addresses the diversity of software capabilities needed by consumer electronics products but also helps cope with fast innovation cycle times by allowing rapid assembly of teams. On the other hand, a large but low-cost resource pool serves as a hedge against business uncertainties while facilitating new software technology introductions within Globetronix. Because, the India center houses R&D activities for many of the Globetronix product groups, arguably such co-located organization of R&D fertilizes cross-group synergies, although there is no compelling example yet of such a synergy. Access to low cost and scalable talent pool determine a majority of work allocation to the India R&D Center, although considerations of sustained competence build up in specific areas is gradually gaining ground.

According to the Managing Director of Globetronix's India R&D Center, innovation is something that creates new businesses and markets, and for that context is the key and customer intimacy vital. Sharing a typology to explain his view on innovation (see Figure 6.12), he observed that it would be another five years before Globetronix India R&D Center can get to the rank of an innovation center and produce innovations that is based on new technology and creates new markets. According to him, Globetronix India R&D Center currently acts almost like a software factory for the various Globetronix business divisions, fulfilling their specified needs.

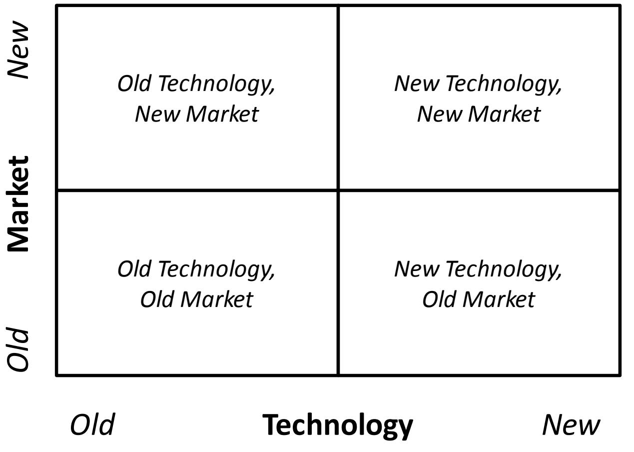


Figure 6.12: Typology for Assessment of Innovation at Globetronix

As of the time of the case study, there were few concrete examples of innovations contributed by Globetronix's India R&D Center, mostly incremental product architecture and technology related innovations. Seen from that perspective, the envisioned evolution of the India R&D Center into a high impact innovation generating center still has some way to go. Because Globetronix India R&D Center has to 'fit' its contributions to pre-defined product architectures, it is clear that it must innovate within a boundary and create differentiation in Globetronix products through software. This offers a narrow scope of innovation for Globetronix India R&D Center and often innovating within pre-specified boundaries might be a constraint. For this to change, and for maximizing the innovative output from Globetronix India R&D Center, the work allocation practices employed to engage the India R&D Center must change. Perhaps, the corporate directive to source software R&D capability from India would also help since that will induce the necessary changes in the practices and mindsets among managers at other locations.

Clearly, for the desired status, the role of the leadership at Globetronix India R&D Center is critical. Interview findings indicate that whenever the local leadership challenged and pushed the limits of what can be done in India, more responsibilities have come to Globetronix India R&D Center. Likewise, the current modus operandi, which involves tapping the resource base at Globetronix India R&D Center to free up innovation capacity at other locations should change for Globetronix India R&D Center to emerge as a true innovation partner for the product divisions.

With shrinking R&D budgets, growing cost-based competition, and increasing role of software for product competitiveness, Globetronix India R&D Center offers an attractive proposition for Globetronix's competitiveness. By strategically leveraging offshore R&D for innovative capability and flexibility the various Globetronix product divisions can achieve triple advantages of cost leadership, sustained market differentiation, and innovation variety and speed in a business environment that is characterized by increasing commoditization, intense cost pressure and increasing technological convergence.

6.6 CASE STUDY VI: FRONTIER SEMICONDUCTORS

This case study is about the offshore R&D engagement between Frontier Semiconductors and Pervasive Technologies.

6.6.1 Background and Context

Frontier Semiconductors is a leading semiconductors company headquartered in North America with sales and research and development operations worldwide. Frontier's 2006 annual revenue exceeded US $10 billion with R&D spend accounting for more than 12% of its total annual revenue. A significant portion of the company's revenue comes from the sale of its core products, which include analog semiconductors, digital signal processors (DSP), and system-on-chip (SoC) solutions. The company also develops customized, application specific integrated circuits (ASIC) as well as application specific DSPs for a range of industries. Frontier is a dominant player in the DSP market, which is one of the fastest-growing sectors of the semiconductor industry. It is one of the leading suppliers of DSPs for the global cellular telephone market.

Frontier operates in an industry which is characterized by continuous, though usually incremental, advances in technologies, product designs, and manufacturing methods. In the semiconductors business, typically new chips are first produced in limited quantities and then gradually ramped-up to high-volume production depending on traction with the markets. Chip prices and production costs tend to decline over time as manufacturing methods and product life cycles mature. Frontier faces intense technological and pricing completion and, therefore, its competitive performance depends upon several factors, including the breadth of its product line as well as technological innovation, quality, reliability and price of its products, and customer support and service. In order to sustain its market leadership, Frontier invests significant capital in R&D but due to the technological and market uncertainties associated with the semiconductors business, return on R&D capital cannot usually be guaranteed. Also, the semiconductor market is highly cyclic in nature. As a result, Frontier experiences significant fluctuations in the demand-supply situations.

Given the cyclic nature of the semiconductor business, the inherent uncertainty associated with semiconductor R&D as well as the high cost of R&D, efficiency and effectiveness in R&D management is very crucial for Frontier. Also, in order to effectively adapt to the changing demand conditions and competitor moves, flexibility is vital for Frontier. Driven by its need to reduce the fixed costs and achieve efficiency in R&D capital expenditures, Frontier has demonstrated a thrust towards offshoring of its R&D activities to cost-competitive locations like India and China. Besides low-cost R&D capacity, offshoring serves Frontier's need for flexibility, which is essential to handle fluctuations in demand and address customer specific needs. In order to provide software and applications support on its products, Frontier also leverages an ecosystem of partners that bring in complementary R&D capability and allow for joint pursuit of market opportunities.

Pervasive Technologies, an India-based wireless communications software company, offers R&D outsourcing services in the areas of semiconductor and communication technologies, and develops and licenses intellectual property blocks for wireless communications systems. In 2006, Pervasive posted annual revenue in excess of US $300 million, nearly 4% of which was spent on R&D, and employed approximately 2500 people spread across its operations worldwide. Pervasive works with high technology companies across the telecommunications value chain (handheld device manufacturers, network equipment makers, semiconductor vendors and network operators) and helps accelerate their product development cycles through a combination of ready-to-use technology blocks and R&D services. Its wireless protocol stacks and multimedia and messaging solutions, which are pre-integrated on major semiconductor platforms and available on major mobile operating systems (Symbian, Windows and Linux), are used by a number of leading cell phone manufacturers worldwide.

Frontier Semiconductors has a multi-faceted relationship with Pervasive Technologies, covering offshore R&D outsourcing and R&D partnership. Based on interviews conducted with managers and technical staff at Frontier and Pervasive during November 2005 and July 2006, this case study seeks to understand how Frontier leverages its offshore R&D outsourcing engagements with Pervasive for innovative capability and organizational flexibility. Table 6.7 provides the details of the interviews conducted to investigate the Frontier – Pervasive offshore R&D outsourcing engagement.

6.6.2 Offshoring of R&D by Frontier

The engagement between Frontier and Pervasive is a multifaceted one and includes joint go-to-market strategy, intellectual property licensing arrangement, and offshore R&D outsourcing services. Frontier's engagement with Pervasive started in 1998 and was primarily catalyzed by Pervasive' intellectual property that complemented Frontier's offerings. At that time, Frontier's engagement with Pervasive employed a two pronged approach: leverage Pervasive's intellectual property on top of Frontier's Digital Signal Processors for delivering complete industry solutions to Frontier's customers, and license Pervasive's wireless protocol stacks for wireless solutions. In

Table 6.7: Details of the Interviews Conducted at Frontier and Pervasive

#	Position/Role	Location	Date of Interview	Mode of Interview
1	Chief Technology Officer, Pervasive Technologies	India	November 11, 2005	Face-to-Face
2	Associate Vice President & Frontier Engagement Manager, Pervasive Technologies	India	December 2, 2005	Face-to-Face
3	Program Manager, Software R&D Services, Pervasive Technologies	India	December 2, 2005	Face-to-Face
4	Engineering Manager, Pervasive Technologies	India	December 21, 2005	Face-to-Face
5	Program Manager, Products Business, Pervasive Technologies	India	December 21, 2005	Face-to-Face
6	Vice President (Products), Pervasive Technologies	India	December 22, 2005	Telephone
7	R&D Program Director, Frontier Semiconductors	U.S.A.	March 8, 2006	Telephone
8	Product Marketing Manager, Frontier Semiconductors	U.S.A.	April 21, 2006	Telephone
9	Technical Manager, Frontier Semiconductors	U.S.A.	July 7, 2006	Telephone
10	R&D Program Manager, Frontier Semiconductors	U.S.A.	July 10, 2006	Telephone

1999, Frontier expanded its engagement with Pervasive to also include an R&D outsourcing relationship. The Frontier – Pervasive offshore R&D outsourcing relationship has grown ever since and now teams at Pervasive work with Frontier's R&D groups located in the U.S., Europe, Israel as well as India, which is where the R&D outsourcing relationship first started. Interestingly, Frontier has its own state of the art R&D center in India that does new product development for global markets.

Narrating the evolution of the engagement with Frontier, Pervasive's Chief Technology Officer, observed:

> *In 2001, our engagement with Frontier deepened with the establishment of a dedicated technology center for Zigma[14]--Frontier's*

[14] ZIGMA is a market leading DSP application processor for high end and mid range cell phones, and fetches several hundred million dollars in annual revenues for Frontier. Application development on ZIGMA is a

> *leading DSP platform for multimedia applications and solutions – at Pervasive. At that time, it was one of the six global Zigma technology centers worldwide. At such a center, Zigma related customer problems, including at customer sites, are addressed. The resources at such centers influence Frontier's image in the market. At the same time, we continued our work on a range of multimedia application products on Zigma processor. Our solutions are aligned with Zigma release roadmap. We are a preferred supplier to many leading Japanese cell phone makers who use our multimedia applications on Frontier's Zigma platforms. Many a times we would be on the critical path of Frontier's sales cycle, so the coordination system between Frontier, Pervasive and the major customers has been matured; there is confidence in the relationship. In fact, there is a lot of senior management touch time between Frontier and Pervasive both for DSP and SOC.*

The establishment and evolution of Frontier's offshore R&D engagement with Pervasive appears to be a confluence of several factors. Certainly, Pervasive's intellectual property in the areas of multimedia solutions and wireless protocol stacks, which complemented and/or augmented Frontier's offerings, was a main driver initially, especially because the complementary innovations and the associated support from Pervasive came at a low cost but proven quality. However, according to several Pervasive executives, during the 2000-2001 downturn the Company was not doing well in the intellectual property business and was looking to deploy people for other activities to improve its revenue. So, this triggered the R&D outsourcing relationship with Frontier. For Frontier, such an outsourcing relationship initially meant utilizing Pervasive engineers for tactical resource augmentation at its India R&D Center. However, later, R&D services from Pervasive grew in its scope and the type of contributions to Frontier.

Clearly, for Frontier to have access to knowledgeable and competent software R&D resources at Pervasive through an R&D outsourcing relationship was attractive, especially because it gave them the flexibility to adapt themselves to the cyclic nature of the market demand at a low cost. Moreover, with the growing importance of software for Frontier's market success, an option to access software R&D capacity at low cost was advantageous for Frontier, especially given that software R&D is not its core competency. A U.S. based product marketing manager for the Zigma platform at

---

very strategic for Frontier. Specifically designed for use in 2.5G and 3G wireless communication and application processing, the ZIGMA family of semiconductor application processors from Frontier Semiconductors serves as a high performance platform for delivering multimedia applications and messaging, streaming media, location-based services, and gaming services.

Frontier explained the role of software and the benefits of the relationship with Pervasive:

> *Typically, a semiconductor manufacturer needs to validate its chips and that requires reference designs. Over the last few years the software part of every reference design has been increasing. Also, for new semiconductors, the vendors not only offer reference designs but also provide software solutions when the volumes are high. For software solutions, good architecture and reusability are critical success factors, especially reusability across platforms. Pervasive products combined with Frontier products form complete customer solutions. We share our product roadmaps with Pervasive so that they can develop complementary products.*

Interviews suggest that a key metric for Frontier's marketplace success is the extent of customer support available for its processors. Also, in order to serve its lead customers and mature its products, especially for use in wireless handsets, performance (speed, power consumption, etc.), quality and scalability assume importance, for example, for multimedia applications. Precisely to address these needs Frontier works with partners like Pervasive.

With demonstrated capability over the years, Pervasive's relationship with Frontier has deepened. As of December 2005, Pervasive had more than 300 people working on 30 plus projects for Frontier at its Offshore R&D Center in India. Explaining the current set of activities that Pervasive performs for Frontier, Pervasive's Associate Vice President and the Engagement Manager for Frontier noted:

> *We do chip design and embedded software for Frontier. We do entire gamut of chip design for Frontier, including verification and validation. We get the specs from Frontier. In software, we do media engine, communication engine, protocol stacks, etc – all things above the hardware layer.*

Now, Pervasive collaborates with Frontier on leading edge projects to target new product introductions and interacts with customers on Frontier's behalf. Pervasive also participates with Frontier on major industry events and road shows to demonstrate its solutions and applications on Frontier's products. Frontier provides information to Pervasive on its product roadmap and release plans so that Pervasive can develop complementary solutions and applications aligned with Frontier's marketing plans. For this, Frontier also provides free development kits to Pervasive.

6.6.3 Organization and Management of Offshore R&D by Frontier

This section provides an account of the organization and management processes Frontier Technologies employs for its offshore R&D engagement with Pervasive Technologies. Specifically, the structural characteristics, relational characteristics, and R&D task allocation practices associated with the engagement are described.

6.6.3.1 Structural Characteristics

Figure 6.13 depicts the governance structure Frontier employs for its offshore R&D outsourcing engagement with Pervasive. There are two types of engagements Frontier has with Pervasive: go-to-market strategy as well as licensing agreement, and R&D outsourcing services. The R&D outsourcing engagement between Frontier and Pervasive is governed by a 'service' contract. For all R&D outsourcing projects, Frontier provides directions to Pervasive teams, specifies requirements, and Pervasive delivers the expected output to Frontier according to a pre-defined schedule and budget.

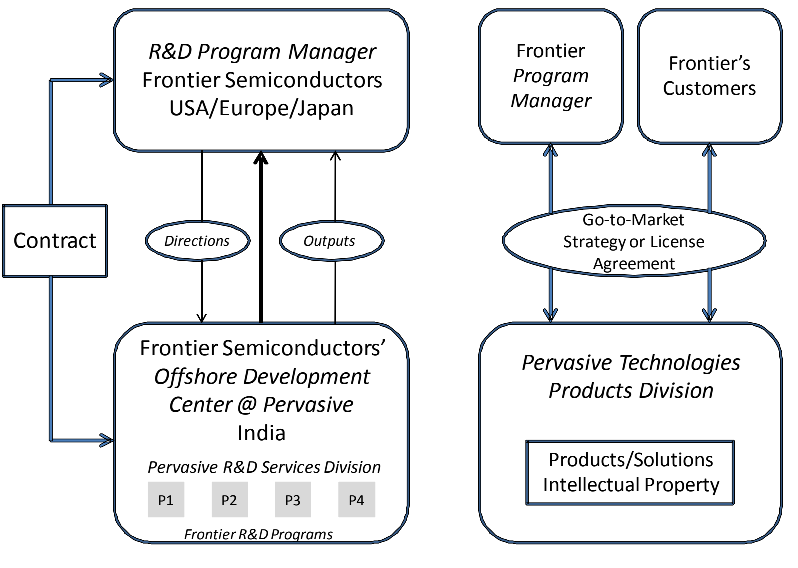


Figure 6.13: Organization and Governance Structure for Frontier's Offshore R&D Outsourcing Engagement with Pervasive

The R&D work assigned to Pervasive is managed by Frontier program managers. Explaining the governance structure for R&D projects outsourced to Pervasive, an R&D Program Manager at Frontier based in the U.S. remarked:

> *I will go to Pervasive only if I have a senior resource at my end to monitor Pervasive team, especially if it is a new development. For maintenance projects I may just handover the work to them. In most cases, a Frontier person is always overlooking Pervasive's work. From past experience we know what it takes to do a job, so we negotiate a schedule with Pervasive and assign to them well-defined work with a timeline.*

Licensing of intellectual property by Pervasive to Frontier is governed by a licensing agreement, whereas Frontier's go-to-market engagement with Pervasive is governed by a business agreement. Under the go-to-market agreement, Pervasive develops multimedia solutions on Frontier's platforms and the two companies together pursue market opportunities to mutually advance each other's business interests.

It may be noted, however, that Frontier's engagement with Pervasive on either front – offshore R&D outsourcing and go-to-market – is not exclusive and that Frontier works with many other partners like Pervasive to support its business needs.

6.6.3.2 Relational Characteristics

Frontier's relationship with Pervasive has matured over a number of years and is characterized by trust, mutual respect, and confidence. Senior managers at both the companies frequently interact with each other and explore opportunities to advance each other's business interests. A product marketing manager at Frontier based in the U.S. observed:

> *Trust and relationships are important. We have a lot of trust in Pervasive's leadership. We have people at Pervasive who know Frontier technologies and they help multiply new team growth.*

The other managers at Frontier that I spoke with echo similar sentiments about the relationship. The fact that Frontier shares its product roadmap and release plans with Pervasive just so that Pervasive can make available corresponding solutions to coincide with Frontier's product launch indicates the quality and value of the relationship. However, a Program Manager at Pervasive, who manages software R&D and works with many Frontier locations, provided some additional perspectives:

> *The relation characteristics vary from location to location. When there is trust in our capabilities, we have a loosely managed structure. When trust is low, the relationship is tightly managed. When there is a feeling of threat, there is a tendency to over control and over criticize.*

In some ways, Pervasive is a competitor for Frontier. Pervasive develops software codecs for multimedia solutions on Frontier platforms as well as other industry leading DSP platforms. Frontier also has an internal software group that develops similar software codecs but there have been situations where Pervasive products were preferred by customers due to their superior performance and extensive customer support availability.

While the R&D services engagement between Pervasive and Frontier has grown over the years, the licensing engagement has seen its ups and downs. For example, earlier Frontier had licensed Pervasive's 3G wireless protocol stack. Frontier also had a similar licensing arrangement with another company, which it later acquired and discontinued the licensing agreement with Pervasive. However, Frontier now has a services agreement with Pervasive to support the protocol stack it acquired from the other company even though this puts Pervasive in a competitive situation with Frontier.

The Frontier – Pervasive offshore R&D engagement is essentially a buyer – supplier relationship, Frontier being the buyer. Interestingly, both firms collaborate on common objectives, and yet being independent business entities, both have the propensity to pursue and protect their respective business interests, which adds to the dynamics in the relationship. In order to mitigate any compromise for its business interests, perhaps that's the reason why Frontier does not have any exclusive arrangement with Pervasive and instead leverages a galaxy of partners.

6.6.3.3 R&D Task Allocation

Frontier engages Pervasive either for tapping its resources for outsourced R&D work or for having it develop solutions and applications on Frontier's processor platforms. For the former, Frontier pays to Pervasive under a contract on a time and material basis, whereas for the latter no monetary exchange takes place between Frontier and Pervasive. Instead, Frontier provides visibility on its product roadmap to Pervasive along with engineering samples and development kits, so that Pervasive can develop innovative solutions and applications that complement Frontier's product offerings and result in complete industry solutions. Pervasive generates its revenue by licensing its solutions on Frontier platforms to various clients but many a times it would be on the critical path of Frontier's sales cycle. Explaining the engagement with Frontier, Pervasive's Chief Technology Officer remarked:

> *To truly demonstrate the functionalities of a DSP or SoC processor, software is essential. For example, for video functionality – video capture, video playback, etc. – unless you show applications you cannot demonstrate chip performance. So, software is very crucial but the problem is that Silicon companies can never make money from software. Also, it is a culture issue for Silicon companies. Software is*

> *not core to Frontier but customers force Frontier to provide certain platform software with chipsets. Software bundling is becoming crucial for Frontier's market penetration. Actually, software has become a necessary evil for chip companies.*
>
> *Pervasive develops multimedia software applications on Frontier's platforms and enables Frontier's sales into lead customers. Without high performance software codecs, Frontier cannot sell its processors. Frontier does have its own multimedia software team but that team focuses on developing software applications usually for lead customers when the processor platform is not stable and is evolving.*

In case of outsourced R&D, the interview findings suggest that Frontier leverages Pervasive for non-core software R&D work, or for gaining temporary access to software R&D capacity for its various development programs as well as to address emergent customer needs. Consider, for example, the case of Frontier's ASIC business unit, which develops System on Chip (SoC) solutions for its customers. According to informants, the business environment for SoC is quite dynamic and the internal staffing budget within Frontier also influences the choice to outsource. A U.S. based R&D Program Director at Frontier's ASIC business division, who manages several SoC projects, observed:

> *SOC execution requires significant resources and I have a limited team responsible for executing a double-digit number of programs. So the outsourcing structure is pretty much dictated to me. We have employed Pervasive to help staff a fairly large team for SOC work – nearly 40 people. Given the availability of engineers and the advantageous cost factors, it made sense to go to India and outsource the work. We prefer to outsource rather than hire the large number of resources to execute SOC so we are able to absorb the dynamic business needs as the SOC market is hard to predict.*
>
> *In the SOC space, having a rich IP portfolio, small area, lower power, cheaper cost and fast cycle time is important. However, we have not engaged Pervasive for IP development. Our IP comes from other areas within Frontier; we reuse a lot of our IP. Pervasive most directly impacts the cost factors and cycle time. Program management and design strategy is done by Frontier, and execution is done by Pervasive.*

Information gathered from the interviews suggests that typically a semiconductor manufacturer needs to validate its chips and that requires reference designs. Over the last few years the software part of every reference design has been increasing. Also, for new semiconductors, the vendors not only offer reference designs but also provide software solutions when the volumes are high. According to several informants, software in Frontier has traditionally been a support activity. As a matter of fact, for Frontier, software has always been an expense[15] and not a revenue generating effort. However, nowadays Frontier cannot sell a chipset without any reference design, a large part of which requires software capability. With its strengths in software, Pervasive augments Frontier's efforts in creating and validating reference designs. An R&D Program Manager at Frontier's Semiconductor Devices and Systems Division based in the U.S. described how his group leverages Pervasive and explained the criteria used in work allocation:

> *We needed resources to validate designs and did not have skilled resources immediately available, so we went to Pervasive. Pervasive provides validation services that we need. We have had difficulty in having our people perform this kind of job. In working with Pervasive, we don't have to go through the hiring process. We train Pervasive engineers on work that is in demand in the industry, so that they can be used on other projects. We usually have Frontier engineers work with Pervasive engineers. In allocating work to Pervasive, I look at our own experience and account for learning curves. I prefer to give the most complicated work to Frontier engineers. That way, we also retain knowledge within. Critical knowledge should be retained.*

A Frontier manager based in Dallas, USA, who is responsible for Zigma product marketing and has been associated with the Pervasive engagement for quite some time now, enlightened on how Frontier engages Pervasive and allocates work:

> *We focus on next generation architecture and core parts, and go to Pervasive for things we can repeat – where customer work requires a large number of resources and we want flexibility. We concentrate on what is critical and wherever we can repeat, wherever we need scalable resource pool, when customers are more, we go to Pervasive. We work with Pervasive primarily because of low cost, not because of any unique capability.*

A technical manager at Frontier's R&D Center in Japan, who earlier worked at Frontier's R&D organization in India, provided additional perspectives on how Frontier has leveraged Pervasive:

[15] It is estimated that currently software accounts for almost 16% of Frontier's R&D expenses.

We used Pervasive for resource augmentation for product development activities at Frontier India. We could not find quality resources quickly. Pervasive had skilled resources in the areas that we could leverage. Also, the kind of activities we had at hand, we were not sure if those activities would last long term and hence it did not make sense for us to ramp-up a team. Otherwise, we would need to find alternate jobs for our resources if the work program discontinued. Also, Pervasive is one of the Frontier partners and has strong competencies in the wireless domain; they can provide good solutions to our customers. We saw this opportunity to ramp-up Pervasive skills on Frontier platforms so that when customers needed customization, we could introduce Pervasive to them. Pervasive's competencies are not really unique but competencies we need – wireless multimedia codecs.

When we get a new customer and if they wanted changes we approach Pervasive for such work. Our customers have diverse needs and to fulfill such needs we go to Pervasive. Typically, we would go to Pervasive when we are bound by resources or if the customer work on the table is not strategic for us. For example, work on our older silicon platform architecture based applications. HQ prefers for us to work with third party resources, especially where roadmap is not clear. If I have a long term roadmap visible to me, I would have my own staff. We at Frontier can hire better quality of people. Also, I will go to Pervasive only if I have a senior resource at my end to monitor Pervasive team, especially if it is a new development. For maintenance projects I may just handover the work to them. Typically, for the multimedia kind of work, we would go to Pervasive. Pervasive has helped us with short term needs and maintenance projects. Our own people don't want to do maintenance kind of work.

For market penetration of any major processor, the extent and quality of customer support is a critical success factor and Frontier leverages Pervasive for such needs as well as for application development on its platforms for customer wins.

Since Frontier has its own R&D center in India, it adds to the dynamics of work allocation to Pervasive. In explaining the pattern and dynamics of work allocation, Pervasive's Associate Vice President and the Engagement Manager for Frontier observed:

Pervasive works with many locations of Frontier but as far as work is concerned, it happens to be a spillover effect from Frontier India center to Pervasive. If Frontier India center can't or doesn't wish to do *some work, then the work comes to Pervasive. This has generally been the case. Typically, we get requirements in the form of number of resources with XYZ competencies. That's not what we want to hear, though. We want to know the scope of a project and execute it with full ownership. At Frontier, the tendency typically is that give me resources with XYZ competencies.*

Frontier prefers joint development when their competencies are not at par with their partners' competencies, where they believe their partners bring value they can learn from. Likewise for a one-time activity like chip design for heart beat monitoring, they come to us. Also, when they have emergent customer requirements, they would come to us for the required resources. Also, Frontier would do platform development and release two platform releases and then handover the platform to us for maintenance and further enhancement. This they do because they want to avoid distributed development.

Overall, it appears that Frontier engages Pervasive for complementary innovations and for access to low cost software R&D capability. On one hand, Pervasive's complementary innovations – solutions and applications on Frontier's platforms – help increase the market acceptance of Frontier's products. On the other hand, Frontier's outsourced R&D arrangement with Pervasive gives it the versatility and scale of resources required to meet market demands at low cost. Besides cost factors and scale, Frontier's matrix structure for executing programs, which is often limited by budget, catalyzes outsourcing software R&D to Pervasive. Outsourcing R&D to Pervasive also gives Frontier the flexibility to handle the cyclic nature of customer demands without having to hire its own staff and incur fixed costs.

Frontier's software R&D capacity is limited and the cost and bandwidth required for developing software for the multiple platforms, especially for launching and customizing new products, is a constraint that it has to deal with. The examination of Frontier's work allocation pattern to Pervasive reveals that Frontier focuses its software R&D teams on new and core work, and offloads work that requires customization, enhancement or maintenance to Pervasive. Through outsourcing of R&D to Pervasive, Frontier gets the ability to adapt and optimize its R&D activities and expenses. This also allows Frontier's internal software R&D teams to focus on core software work – bridge software, reference codecs, basebands and drivers and strategic applications.

6.6.4 Offshoring of R&D and Frontier's Innovative Capability

This section presents findings related to (a) generation of innovation by Pervasive for Frontier and (b) transfer of knowledge from Pervasive to Frontier.

6.6.4.1 Innovation Generation by Pervasive

In the context of offshore R&D engagement between Frontier and Pervasive, examination of innovation assumes two dimensions: complementary innovations that Pervasive contributes on top of Frontier offerings and generation of innovation by Pervasive for Frontier under offshore R&D outsourcing contracts. This case examines both the dimensions. Informants at Frontier readily acknowledge that Pervasive's products greatly complement Frontier's innovative offerings and that there have been cases where customers have changed their decisions in favor of Frontier due to Pervasive's codecs on Frontier platforms. Frontier does have its own internal software teams that develop similar codecs but their primary focus is on demonstrating processor features and capabilities and not necessarily developing high performance codecs for field use. Pervasive, on the other hand, develops high performance multimedia software codecs for commercial use and licenses these to clients. And, as such, the Pervasive products mature due to repeated use across clients and thus deliver optimal performance. This enables Frontier's sales into lead customers. According to a Technical Manager at Pervasive:

> *Today a lot of Pervasive multimedia solutions ship on Frontier's Zigma processor. Almost 45 phones in mobile the handset market segments use Frontier's Zigma processor and 32 of these use Pervasive solutions.*

There have been numerous instances where a market opportunity materialized for Frontier due to proven products from Pervasive on Frontier's platforms. A Technical Manager at Pervasive recalled an instance when Pervasive came to Frontier' rescue in a challenging customer situation:

> *Frontier had suggested to a major cell phone maker in Japan that using a particular hardware configuration would render the project unsuccessful and that an upgrade to a new Frontier processor would be required for the specific product since the solution Frontier had did not work. The client had a very rigorous performance specification. At that time, we proposed to Frontier that we had a solution. This was a solution on an application processor for mobile handsets under the Zigma family. Our solution saved time and money for the customer and also contributed to the strengthening of the relationship between Frontier and the customer. This also resulted in huge sales volume for Frontier. Later, we again worked with the same Japanese cell phone maker for their next generation handsets.*

The focus of this case study, however, is to investigate generation of innovations in the context of Frontier's offshore R&D outsourcing contract with Pervasive. Towards that, no compelling case of innovation that Pervasive has contributed to Frontier exists. Most of the instances of innovation can be categorized as incremental at best, and the informants on both the sides confirm this assessment. Consider, for example, the following remarks of the Chief Technology Officer of Pervasive:

> *Innovation…it is tough to describe…we have a lot of implementation innovations, architectural level innovation, in line with Frontier architecture. But, I don't think we have any significant breakthrough innovation…but more of incremental innovations.*

An R&D Program Director at Frontier's ASIC Business Division in the U.S., who works with Pervasive on SoC projects, provided detailed perspectives on the aspect of innovation in the context of Frontier's R&D outsourcing relationship with Pervasive:

> *In the SOC space, having a rich IP portfolio, small area, lower power, cheaper cost and fast cycle time is important. Pervasive most directly impacts the cost factors. I have not seen any innovations from Pervasive, including time to market. Our IP comes from other areas. We reuse a lot of our IP. Pervasive has not come to me with any proposal or ideas to improve power, size, etc., and actually we have not engaged Pervasive for IP development. SOC design is very complex and we need to do it based on what the customers need. We need to integrate multiple IP blocks for turnkey designs and in such cases Pervasive gives inputs on development specs. Such programs need a large number of staff. For such programs Pervasive contributes specific functions our customers request.*
>
> *I find it hard to think about any innovation Pervasive has contributed. Pervasive has met expectations – contributing committed deliverables on schedule within the low cost structures we have set-up. Pervasive has done a good job of execution of ASIC development work – a lot of dedicated hard work. However, it is hard for me to say if Pervasive did anything innovative or exceptional above or beyond what was expected. I think I would struggle…*
>
> *I think the impact of the engagement on innovation would be positive because fresh engineers bring different perspectives provided they are senior enough to add value. The impact is negative if we don't get the same engineers in whose learning curves we have invested in the past. But there is a sacrifice for innovation because of turnover. With cycle times shrinking, it gets more and more challenging to commit aggressive schedules if the team is not stable.*

Another Technical Manager currently at Frontier's Japanese R&D Center, who has extensively worked with Pervasive, believes that the R&D outsourcing engagement with Pervasive has no impact whatsoever on innovation as far as Frontier is concerned, although he, too, confirms the assessment concerning complementary innovations that Pervasive brings to Frontier through its intellectual property blocks. In his view:

> *I don't think there is much of an impact on innovation, either positive or negative. People from Pervasive work on routine tasks or maintenance tasks. Usually, Frontier people would do design and Pervasive people will implement. But Pervasive's product groups have produced a lot of innovations – new algorithms, code reuse across customers, and this has helped customer projects because Pervasive would have a ready solution on Frontier platforms.*

According to the informants at Frontier, the potential for innovation exists and that potential is not realized for a multitude of reasons. It appears that the main reason for the scarcity of innovation has to do with how work is allocated to Pervasive and how the engagement is structured as also the business motivations of the two firms involved. This is reflected in the perspectives shared by Frontier's Product Marketing Manager for Zigma based in the U.S.:

> *Innovation! None. We drive Pervasive as a backend center, not as an innovation center. There might be innovation in such areas as optimized codecs. However, I have not seen the kind of innovation that will impact our business. This could be because Frontier may not have shared enough information for Pervasive to contribute to innovation. Perhaps there is a correlation between work allocation and innovation. There might have been some innovations but those are not visible outside. Pervasive brings in process innovation but that is something not very crucial for us.*
>
> *Pervasive's interest is in securing business that can be scaled. Pervasive is usually interested in time and material projects. Pervasive really does not have the incentive or motivation to innovate. Innovation would be antithesis to their business model. For Frontier, product innovation and quality are very crucial. Mostly, testing, validation and integration kind of work goes to Pervasive. For Frontier, time to market is crucial and Pervasive provides us scalable resources to address multiple customer needs, even at low chip volumes. Pervasive helps us accomplish augmentation possibilities on base product at low cost.*

Similarly, the other informants at Frontier believe that the work assigned to Pervasive is such that it has no scope for innovation, although they also think that such R&D outsourcing engagements do not negatively impact Frontier's ability to innovate. However, the informants at Pervasive associated with the Frontier engagement believe that they have contributed many architectural and process level innovations that have helped Frontier in no insignificant way. Providing a snapshot of Pervasive's innovation contributions to Frontier, its Associate Vice President responsible for the Frontier engagement observed:

> *There have been many implementation innovations such as design for management of processor bandwidth. Similarly, our EDGE protocol has outperformed their GSM/GPRS protocol stack, in terms of quality and performance. The highest selling video phone in the UK decided to use Frontier platform primarily because of Pervasive codecs. Actually, Pervasive played a major role for this decision in favor of Frontier's Zigma platform by developing a solution on Linux operating system and also received appreciation from Frontier for our contribution.*
>
> *In general, our ability to innovate is restricted by work scope. We help Frontier by increasing their market share, reduce cost, or displace their competition. But when porting of products on new platform happens, we can innovate.*

Another Program Manager at Pervasive, who has been associated with the Frontier engagement on handled software R&D work, shared his perspectives on Pervasive's innovation contributions to Frontier, why those are significant, and what barriers are involved in maximizing innovative outputs:

> *We define processes for Frontier that saves them product development costs and cycle times. For example, the interoperability processes that we have developed have been adopted by Frontier units worldwide. Interoperability testing is a very costly process and costs about US $7000 a day at Interoperability Testing Facilities. As part of the robust testing process that we introduced, we developed a method for problem detection early in the process than at the interoperability testing stage. This helped reduce about 20% of the interoperability testing costs.*
>
> *At product level we have not done any innovations, nor at technology level. This is due to the nature of the relationship – what is desired and what is expected. Our contributions are at the computing level, architecture level and implementation level. We have done many algorithmic improvements. For example, with their latest processor for*

> *handsets, they were planning to save US $2000 and we helped save US $12000 through reduced use of memory in L2 – L4 layers*[16]*. Similarly, in WMA codecs, we reduced MIPS by 25% as opposed to targeted 10%. These innovations are not related to product, domain or market – they are all compute level innovations, which is where our natural capabilities lie. Every transistor on the chip costs money; less transistors means less memory on the chips and therefore the cost of the chip is reduced, which in turn reduces the cost of the wafer. So, margin increases or the cost to the end customer reduces.*
>
> *One necessary requirement for innovation is the availability of time and space. We have a milestone bound, fixed schedule – it's like backseat driving. You are in driver's seat but your instructions are coming from elsewhere – you cannot make your own decisions.*

Interviews suggest that the Frontier project teams at Pervasive work on technologies that are defined by standards, so there is a restricted scope for innovation. Moreover, generally Pervasive gets involved with Frontier projects when engineering samples become available. By that time, the Frontier product architecture and design are usually finalized, so the scope for direct contribution to product innovation for Frontier is minimal. But Pervasive's innovative solutions complement Frontier's offerings and heighten their market appeal. Additionally, a new phone launch cycle typically is 10-12 months, and the design-win to design-in ratio is 1 to 6 or even lesser. Data provided by Pervasive suggests that out of every 7 design-ins, 2 design-wins have Frontier software. Informants at Pervasive claim to have overcome many technical challenges for Frontier and also developed a highly effectively method for application development on Frontier's Zigma platform. According to them, their method has proven to be more effective than what Frontier had proposed. The Pervasive method has helped reduce integration complexity for application developers as well as the Frontier me for debugging, and allowed for innovative use cases.

Irrespective of the quantum and type of innovations, Pervasive's influence on Frontier's revenue and market success cannot be ignored. Based on the information gathered from the interviews as well as other market sources, Pervasive has played an instrumental role in influencing revenues for Frontier, particularly in the Japanese market. Besides its high performance multimedia solutions on top of Frontier's platforms, the innovation capacity available at Pervasive has helped Frontier address diverse and emergent market needs while also contributing architectural innovations that have resulted in improved product performance for Frontier.

[16] There are four layers comprising a solution based on Frontier processors: Chip/Hardware, Baseband DSP, Modem, and Applications.

6.6.4.2 Knowledge Transfer from Pervasive to Frontier

In this section, findings concerning reverse learning and knowledge integration from Pervasive to Frontier are presented. As such an evaluation of an intangible aspect like learning is difficult to assess, as the perception of the value associated with learning and knowledge is usually contextual in nature. However, by and large, reverse learning and knowledge integration does not seem to be a matter of explicit interest for Frontier in their offshore R&D engagement with Pervasive. Moreover, conversations with Frontier managers suggests that there have also not been any instances of incidental learning that they identify as having assimilated from Frontier. On the contrary, interviews reveal an operational challenge Frontier faces in working with Frontier, as illustrated by an R&D Program Director at Frontier's ASIC Business Division in the U.S.:

> *The value add of Pervasive is that we can build large teams and handle capacity issues well and quickly. But the problem is that I may not get the same resources again. I have created a learning curve that I cannot leverage on the next program. Once I use some Pervasive people, train them on our IP, not having them on the next program obviously is detrimental when compared to retaining a permanent employee.*

The other Frontier managers that I spoke to expressed similar concerns about knowledge loss due to movement of people and suggested that they insist on documentation to cope up with this challenge besides having Pervasive engineers work with Frontier engineers to facilitate exchange of ideas and knowledge. According to an R&D Program Manager at Frontier's Semiconductor Devices and Systems Group in the U.S.:

> *Pervasive provides validation services that we need. We have had difficulty in having our people perform this kind of job. We train Pervasive engineers on work that is in demand in the industry, so they can be used on other projects. However, there is a risk of knowledge loss and that's a huge downside. We usually have Frontier engineers work with Pervasive engineers. There is also documentation process that needs to be followed.*

Regular interactions and meetings between teams at Pervasive and Frontier provide a conduit for exchange of learning and knowledge flow between them. And, documentation as required by the development processes also enables capturing of knowledge in an explicit manner. But there are hidden aspects of learning and knowledge integration for Frontier in this engagement that seem to go unnoticed. For example, Pervasive's product group, which develops solutions on top of Frontier platforms, and the R&D services teams at Frontier's Offshore Development Center at

Pervasive, interact with each other and enrich each other's efforts through their prior knowledge and experiences, which eventually benefits Frontier. However, not everyone at Frontier subscribes to this perspective. For example, an R&D Program Director at Frontier's ASIC Division observed something in contrast:

> *They should improve on their internal information sharing, so that even if I won't have the same people on the next program I can minimize the learning curve. That way, they don't have to turn back to us for ideas.*

Managers at Frontier agree that Frontier derives learning and integrates knowledge from its Zigma Technology Center at Pervasive, which develops solutions and supports Frontier's customers on Zigma platform. Pervasive provides feedback on Frontier processor architectures as well as tools (compilers, linkers, debuggers and development boards), which help Frontier improve its products. Likewise, the interviews indicate that Pervasive has contributed to Frontier's learning in the areas of wireless protocol stacks and software development processes. However, managers at Frontier don't consider such learning as significant or critical for Frontier. That learning and knowledge integration is not an objective for Frontier in this offshore R&D outsourcing engagement is also evident from the lack of any formal mechanisms deployed for the purpose. The only formal element in the engagement that serves as a coordinating mechanism for assimilation of learning and knowledge exchange is Frontier Program Managers responsible for the specific R&D programs.

6.6.5 Offshoring of R&D and Frontier's Organizational Flexibility

Given the cyclic nature of the semiconductor business and fluctuations in customer demand, the ability to adapt to its environment is crucial for Frontier. Therefore, flexibility is vital for Frontier's competitiveness. It appears from the interviews with Frontier as well as Pervasive executives that Frontier's need for flexibility is well served through its offshore R&D outsourcing engagement with Pervasive. First of all, Pervasive offers Frontier the ability to access R&D resource pool at low cost and on an on-demand basis without having to incur any fixed R&D costs. This allows Frontier to effectively address emergent market priorities in a swift fashion, as exemplified by the following remarks of an R&D Program Director at Frontier's ASIC Division in the U.S.A.:

> *SOC requires a lot of resources and with Pervasive we can build large teams quickly and handle capacity issues well. Given the availability of engineers and the cost factors, it makes sense to go to India and outsource work. We prefer to outsource such work so as to be able to absorb the dynamic business needs. Pervasive offers us flexible R&D capacity.*

A detailed perusal of the interview findings suggests that Frontier develops processors and chips and once the initial versions are stabilized, it engages Pervasive for their maintenance and enhancements thereby releasing its own resources on new R&D programs. Similarly, Frontier's software teams develop reference codecs for verifying the features and capabilities of the new processors but for actual commercial purposes, they often leverage their relationship with Pervasive. In addition, the interviews provide evidence that Frontier leverages their outsourcing relationship with Pervasive for custom development that specific customers may require. Moreover, outsourcing parts of R&D work to Pervasive allows Frontier to focus its resources on more value added tasks. Talking about how Pervasive enables flexibility for Frontier, the Product Marketing Manager for Frontier's Zigma platform, said:

> *Meeting or beating the market is crucial for us, and for that we need flexibility. For us, time to market is very crucial and so are outsourcing partnerships such as the one with Pervasive, which gives us flexibility and scale. At Pervasive, we get resources that have the relevant background – both technical and domain knowledge. With a scalable resource pool we can address multiple customer needs even at low chip volumes. We can also augment our base products at low cost with Pervasive.*

Explaining how partners like Pervasive serve Frontier's need for flexibility, the Chief Technology Officer of Pervasive provides some additional perspectives:

> *Flexibility is very important for Frontier's software needs. Applications can be done cheaply on silicon but the reason software is used instead is because of flexibility needs, because standards keep evolving and upgrades via software on a DSP platform are easily possible. So, a software ecosystem is vital for Frontier's processor success.*
>
> *In addition to the staffing flexibility, we also provide management flexibility to Frontier – we provide management bandwidth to Frontier and help them manage peak loads. Also, for chip variants that customers require, the Pervasive relationship gives Frontier a flexible but effective way to handle that.*

The market environment in which Frontier operates is quite unpredictable. Narrating the dynamics of the market environment and how the relationship with Pervasive helps Frontier cope up with the emergent market opportunities, Pervasive's Vice President observed:

> *Flexibility is very crucial for Frontier in the smart phones market, where there are multiple mobile operating systems – Palm, Windows CE, Symbian and Linux. While planning their chipsets, Frontier cannot have visibility into which operating system will win out. Samsung and Motorola can change their plans on which operating system they want to use and Frontier has to support their chipsets for that. This shows the market dynamics. This dynamics could be addressed through partners. In one instance, Frontier was developing a customized chipset for one of its customers and midway they realized that the chipset had a larger market. But they had not planned R&D effort for that. The Chipset was aimed at the Japanese market but later they found that Motorola, Nokia and Samsung were also interested, and so they worked with us for a multimedia software solution and thereby multiplied their R&D capacity.*

Frontier has a matrix structure for executing programs, which is limited by a budget. A program's objective is to introduce a new product technology in the market with a pre-defined timeline and budget. Frontier's resource strategy is in alignment with market forecasts. As such, given the high uncertainty in the semiconductor market as well as high cost of R&D, Frontier seeks to optimize its fixed costs. An R&D outsourcing relationship gives Frontier the ability to adapt to the changing market conditions and optimize its costs. Similarly, when a new product is launched by Frontier, the amount of support needed is usually very high initially. Frontier's customers have stringent and time critical support requirements especially for cell phones to go into production. However, over a 2-3 year period this need for customer support declines. This requires a suitable ramp-up and down of skilled resources dictated by external markets, and the outsourcing partnership with Pervasive serves Frontier on this front as well. Essentially, Pervasive offers an elastic supply of support capability to Frontier.

Informants at Pervasive believe that Frontier also benefits because "Indians have flexibility and adaptability," and such cultural and work-hour flexibility is of very big value. But managers at Frontier do not indicate any such thing. However, since for its processors like Zigma Frontier uses an ecosystem of partners for application development, competition among the partners gives an advantage to Frontier because that way its customers get more choices.

6.6.6 Impressions from the Frontier – Pervasive Offshore R&D Outsourcing Engagement

Frontier's two pronged approach to engage Pervasive offers it complementary innovations, reduced R&D cost, floating R&D capacity, increased market penetration, and reduced TCO for its products. On one hand, by leveraging Pervasive's innovations in software solutions on top of its processor platforms, Frontier offers its customers a compelling value proposition, including support, at lower costs. On the other hand, Frontier's R&D outsourcing arrangement with Pervasive give it access to an R&D capacity that comes at low cost with a competent resource pool. The R&D capacity that Pervasive offers to Frontier instills considerable flexibility in Frontier's operating environment and allows it to address fluctuations in market demands without having to hire or layoff its people. In every sense, being able to address the emergent priorities and address customer support requirements effectively without incurring fixed costs is a benefit Frontier derives through its offshore R&D engagement with Pervasive.

Although some Frontier managers point out that that their preference for the scalable and flexible R&D capacity results in a compromise for learning and productivity, there is no evidence that this results in any compromise for the output quality. Pervasive follows Frontier's processes and methodology, and has installed multiple checks and balances so that quality and schedule of work products is honored. Frontier's partnership with Pervasive ensures the availability of the required multimedia solutions almost concurrently with the release of a new processor at low investments, which also helps in rapid customer acquisitions. Pervasive's contribution to Frontier's market performance is evident from the available statistics: almost 45 phones in mobile handset market segments use Frontier Zigma processor and 32 of these use Pervasive solutions.

While the offshore R&D outsourcing relationship between Frontier and Pervasive provides ample evidence for how such an engagement offers considerable operational and structural flexibility to Frontier, the lack of reverse learning and knowledge integration as well as the quantum and types of innovations seen in the engagement point to some interesting aspects. It appears that for Frontier neither learning nor knowledge integration is an objective in such engagements. Similarly, innovation generation is not a primary objective, and this is clearly reflected in the way the work is allocated to Pervasive. Frontier does, however, benefits from the complementary innovations that Pervasive produces on its processor platforms by way of multimedia software solutions and applications, but that does not really fall within the purview of offshore R&D outsourcing engagement. Instead, that is a result of Pervasive's own product and IP focus as part of its partnership with Frontier. In this regard, the relationship between Frontier and Pervasive can be seen as a value web where two players do things in conjunction with one another in order to advance each other's business interests in a mutual fashion but no direct benefit flows from any one to the other. Instead, each benefits from a third player depending on how the two players work with each other complementarily.

The Frontier – Pervasive offshore R&D engagement also highlights another aspect in terms of each party's expectations in the relationship. While discussing the aspects related to innovation, the Frontier managers explicitly stated that innovation was not an objective in engaging Pervasive. But several of them also felt that there was ample scope for innovation by Pervasive and it was just that Pervasive engineers were not forthcoming in suggesting new ideas and improvements. On the other hand, Frontier does not have an exclusive partnership with Pervasive and nor does it assure business to it. Many managers at Pervasive that I interviewed observed that they don't see any coherent strategy from Frontier for partner management. According to them, Frontier seems to have a concern that it may let any one partner influence its customers too much, and so it does not want overdependence on any one in particular. In such a situation, Pervasive does not really have any incentive to innovate for Frontier under its R&D outsourcing engagement. Moreover, Frontier's engagement approach as described above and Pervasive's time and material based services business model do not pave the path for generation of major innovations by Pervasive for Frontier.

6.7 CASE STUDY VII: PENTAGON, INC.

This case study is about Pentagon, Inc.'s offshore R&D outsourcing engagement with Excel Technologies.

6.7.1 Background and Context

Pentagon, Inc., headquartered in North America, is a high technology company in the business of developing and selling products for digital media production, management and distribution. It posted revenue in excess of US $750 million in 2006 and spent more than US $100 million in research and development. With an employee base of more than 2400 people, Pentagon has research and development centers in many parts of North America and Europe. Its products are used worldwide for both media production and post-production activities, including content creation, storage, and broadcast. It has received several prestigious awards, including Oscar, Emmy and Grammy for its technological innovations.

Pentagon operates in a dynamic environment and needs to effectively deal with rapid changes in technologies and customer needs. Its marketplace success depends on several factors, the key among them include: the ability of its products to support a variety of standards and media handling formats, the availability of its products on a variety of computer platforms and operating systems, interoperability with its own and other vendor's products, and speed to market with new products and features. Efficiency in customer services is also quite vital for the company. Its product technologies are standards-driven, whereas its competitive landscape is increasingly fragmented. In creation of its products, Pentagon sources components from many suppliers and also externalizes its R&D.

Excel is a large, Indian IT and R&D services company with an employee base of more than 55000 people and 2006 annual revenue in excess of US $2 billion. Excel provides IT and R&D outsourcing services to Fortune 2000 clients globally and is well-recognized for its service excellence. The company provides engineering services to clients in a wide variety of industries ranging from aerospace and automotive, telecommunications, semiconductors, enterprise software products, and discrete manufacturing.

In September 2005, I interviewed several people at Pentagon and Excel to investigate in-depth how Pentagon was leveraging Excel for its competitive needs of innovative capability and organizational flexibility. At that time, 60 Excel engineers were working on various R&D projects for Pentagon. Table 6.8 provides the details of the interviews conducted for the case study.

Table 6.8: Details of the Interviews Conducted at Pentagon and Excel

#	Position/Role	Location	Date of Interview	Mode of Interview
1	Vice President, Software Development, Pentagon, Inc.	U.S.A.	September 23, 2005	Telephone
2	Director-Engineering, Pentagon, Inc.	U.S.A.	September 23, 2005	Telephone
3	Manager, Codec R&D, Pentagon, Inc.	U.S.A.	September 15, 2005	Telephone
4	Engineering Manager, Pentagon, Inc.	U.S.A.	September 14, 2005	Telephone
5	Manager, Software, Development, Pentagon, Inc.	U.S.A.	September 16, 2005	Telephone
6	Senior Project Manager, Excel Technologies	India	September 19, 2005	Face-to-Face
7	Technical Lead, Excel Technologies	India	September 21, 2005	Face-to-Face
8	Technical Architect, Excel Technologies	India	September 22, 2005	Face-to-Face
9	Project Lead, Excel Technologies	India	September 23, 2005	Face-to-Face
10	Group Project Manager Excel Technologies	India	September 23, 2005	Face-to-Face
11	Project Manager, Excel Technologies	India	September 23, 2005	Face-to-Face

6.7.2 Offshoring of R&D by Pentagon

Circa 2001: The video part of Pentagon's business was not in a very good shape. It did not have any new products in the pipeline and its existing video editing product was in a catch down mode. So, Pentagon was looking to reduce costs, and embarked on a product portfolio analysis to determine what could be offshored. Pentagon's motivation to consider offshoring of its R&D activities at that time had twin objectives: find a way to sustain the product at low cost and take the burden of product sustenance off the Pentagon R&D engineers so that they could focus on new product innovation. The then Vice President of Software Development at Pentagon, who had earlier offshored R&D to Excel while he was part of another company, persuaded Pentagon to engage Excel. Thus, in 2001, the Pentagon-Excel offshore R&D outsourcing engagement was established. At that time, it was prohibitively expensive for Pentagon to hire good quality engineers in North America, whereas Excel provided access to a large, English-speaking talent pool at low cost structures. Since then, the relationship has seen its ups and downs, and is characterized by high drama.

At one point in time, Excel performed outsourced R&D activities for most of Pentagon's product lines, spanning media composition products, media asset management, media storage and management products as well as media broadcast products. However, lately, the volume of outsourced activities to Excel has declined. As of September 2005, Excel had a 60-member team working for Pentagon in the areas of codec development, integrated media editing platform, and broadcast server product. The codec development activity initially started with porting of a codec for video compression and decompression to a different platform, and later included new codec development. As of September 2005, most of Pentagon's codec development work was being done at Excel. Nearly 30 Excel R&D engineers now staff Pentagon's codec development projects for its media creation products. 10 Excel people work on Pentagon's media editing platform and are involved in maintenance and enhancement.

The broadcast server product, which Pentagon acquired from another company, was straight handed over to Excel for sustenance. This product, however, had a dependency on third party suppliers for components and so Pentagon needed to come up with a new version of the product that could alleviate the dependency. Excel created the new version of Pentagon's broadcast server product, taking end-to-end responsibility, but incurred a considerable delay in completing the project. As a result, even though the new product that Excel developed eliminated the third-party dependency and brought down the cost of the product by one-fourth, Pentagon took over the control of the project along the way. Since then, the Excel team works as an extended engineering team for Pentagon's broadcast server product. As a result, the size of the Excel team on the broadcast server product reduced to 20 people from its peak size of 35 people.

Several factors have caused the ups and downs in the evolution of the Pentagon-Excel engagement. First of all, over the years Pentagon has found that the cost advantage it initially got by working with Excel is diminishing because of increased rates charged by Excel. Second, Excel R&D engineers possess good, generic technical skills but lack the domain knowledge that is crucial for product development for Pentagon's high technology products. As a result, only certain kind of work could be awarded to Excel. Third, Excel periodically rotates the engineers deployed on Pentagon projects both to support its own business objectives and engineers' career objectives, whereas for Pentagon such cycling of people results in loss of knowledge. Also, since Pentagon does not commit any steady and sizable volume of business, Excel finds it hard to not rotate people to serve on other projects. Finally, on many instances the work being done at Excel was affected due to non-availability of specialized equipments that were necessary to effectively perform the R&D. However, such equipments are not only expensive but bringing them to India also involved some regulatory and logistical constraints.

6.7.3 Organization and Management of Offshore R&D

This section provides an account of the organization and management processes Frontier Technologies employs for its offshore R&D engagement with Pervasive Technologies. Specifically, the structural characteristics, relational characteristics, and R&D task allocation practices associated with the engagement are described.

6.7.3.1 Structural Characteristics

All Pentagon R&D projects at Excel are governed by a memorandum of understanding that specifies the overall terms and conditions, the intellectual property rights, and the cost structures for R&D services. Under the umbrella agreement that governs the engagement different product groups of Pentagon employ Excel for their R&D needs differently. All projects executed by Excel for Pentagon adopt a fixed-price model. Some groups use Excel as an extended engineering team, whereas the other groups have Excel perform well-defined pieces of R&D work. However, all R&D project teams at Excel report into their corresponding product group directors in Pentagon and as such no team at Excel has any direct interface with Pentagon's project or product management organizations. Figure 6.14 depicts the governance structure for the Pentagon-Excel engagement.

6.7.3.2 Relational Characteristics

Interviews suggest that at the individual project level, there is good flow of information and teamwork. Excel teams are seamlessly integrated into Pentagon's product R&D organizations and the relationship between the team members across locations is cordial. Excel team members also often participate in Pentagon's internal team meetings. Even though the relationship has seen its ups and downs, at the time of the

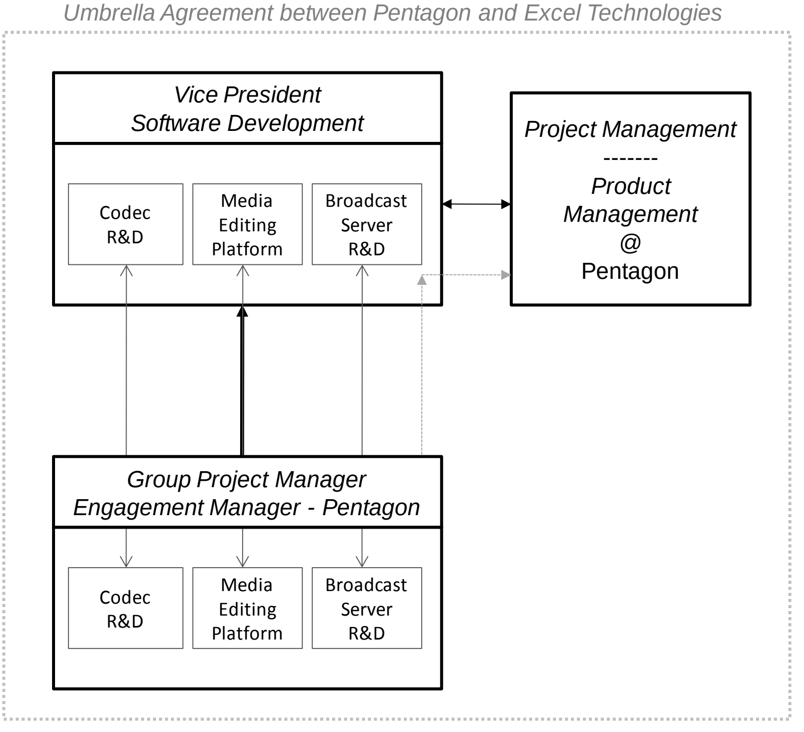


Figure 6.14: Organization and Governance Structure for Pentagon's Offshore R&D Outsourcing Engagement with Excel

case study it seemed quite stable. According to Excel's Group Project Manager responsible for the Pentagon engagement, the relationship between Pentagon and Excel is neither trust based nor suspicion based; it is really need based. Members of the Excel team I interviewed, however, felt that because of the nature of the outsourcing arrangement, they are at times disadvantaged.

An Excel project lead, who has been part of the Pentagon engagement since 2003, observed:

> *Customers squeeze us more, and we often reciprocate with abnormal levels of our commitment. Yet, any mistake we do will be highlighted whereas anything that goes wrong at their end will be treated as normal.*

The relationship at the level of the engagement, however, shows signs of considerable strain, which primarily arises from a misalignment between the two companies business models. Pentagon projects require highly experienced engineers but Excel keeps rotating its engineers and re-deploys them other projects. Pentagon's primary objective in engaging Excel is to achieve staffing flexibility at low cost structures, whereas Excel business model requires a sizable, predictable and long-term business commitment from Pentagon. In the absence a sizable and long-term commitment, Excel's motivation in working with Pentagon is reduced to treating Pentagon projects as training ground for its engineers and develop credentials that can be leveraged with other clients. The following quotes from the interviews provide insights into the dynamics of the relationship and point to the sources of strain.

> *Pentagon needs to have a critical mass of experienced people to outsource R&D work. However, for Excel to have three experienced people on the same team disturbs the hierarchy. – Group Project Manager, Pentagon Engagement, Excel Technologies*

> *To take care of people's career and growth, Excel cycles people through various projects. But for us, it amounts to really losing a person as in people leaving the company. It impacts us. Projects like broadcast server have suffered. People's departure means taking away knowledge. – Vice President, Software Development, Pentagon, Inc.*

Re-deployment of resources by Excel from Pentagon account to other customer projects requires Pentagon to invest in the learning curve of new engineers, and this affects R&D productivity. The relationship is also characterized by a tight oversight by Pentagon for the projects being done at Excel to alleviate any risk of things going wrong.

6.7.3.3 R&D Task Allocation

The allocation of R&D work by Pentagon to Excel is driven by the need to gain access to engineering talent at low cost structures while having the flexibility to vary the staff size in alignment with the need. The work allocation to Excel is based on three criteria: the work to be outsourced does not require domain knowledge, there are no intellectual property related sensitivities involved, and the work has well-developed specifications. The work allocated to Excel is purely technical in nature and does not involve any project management activities or interfaces with the market facing groups of Pentagon. Typically, the architecture level ownership is retained at Pentagon, and Excel is asked to work on specific components that do not require any domain knowledge. The work allocation is also done in such a way that it does not lead to any knowledge dependency for Pentagon on Excel.

Except for the broadcast server product, which involved new development from scratch, most of the work that Pentagon engages Excel for are product maintenance and enhancement projects or component development projects. Typically, the interviews suggest, Excel is engaged on projects whenever Pentagon has a need to free its expensive and experienced R&D engineers for exploring new ideas and product possibilities. All new projects outsourced to Excel tend to be a derivative of what Excel people have already worked on before. Moreover, outsourcing of R&D projects to Excel is also influenced by such considerations as need for specialized equipment because the lab infrastructure in Excel has a limited set-up. Explaining the work allocation philosophy, Pentagon's director for Engineering observed:

> *We make sure that everything that gets to them is very well defined, very explicitly defined. We validate their estimates because at times we find that their estimates are on the higher side…our main concern is to do with overdependence on them, especially if we need to terminate the relationship... The concern is related to IP, especially its linkage to competitors.*

For example, a small team at Pentagon does the algorithm research and specifications development for codes, whereas Excel carries out the development work. For all the work that is outsourced to Excel, the necessary knowledge is retained at Pentagon. Moreover, Pentagon has expert and knowledgeable R&D engineers who remotely supervise the work at Excel. Pentagon managers realize that collaborative work creates interdependencies, which might affect outsourcing effectiveness, and so there have been instances where the complete work ownership, including project management, was transferred to Excel. A case in point is the broadcast server product, which was fully developed by Excel but as such the Pentagon managers don't consider the project to be very successful. Pentagon's Manager for Software Development for the Broadcast Server Product remarked:

> *We thought it was an easy way to induct resources but we got into issues with respect to project management as well as the relationship between development and product management. And this affected the quality of the product because of the reduced interaction between engineering and the other groups. We don't have a very formal process for writing specific and detailed requirements – we have a lot of loose, ongoing requirements between engineering and product management. We had problems with the broadcast server product – it was way off the mark.*

According to managers at Pentagon, the problems with the broadcast server product development were not caused due to a lack of competence or capability at Excel.

Instead, it had to do with a lack of understanding of the market and the domain. Moreover, further complexities were added due to the continuous evolution in requirements. So, as a result of the learning from the broadcast server product development, the Pentagon managers now pay particular attention to not outsource work where the specifications are not well defined and stable. Mangers at Pentagon also realized that in order to effectively leverage offshore R&D outsourcing, good processes and a common set of guidelines, tools and language are required besides frequent communication. The team members on both the sides confirm that ever since upfront planning and a common development processes have been adopted, all product releases have taken place on time and problems eased.

Narrating the constraints and challenges associated with work allocation, and summarizing his experiences with offshore R&D outsourcing with Excel, Pentagon's Vice President of Software observed:

> *Given the knowledge that is required to develop our kind of products, generic engineering skills won't suffice. This is what the people here have experienced. Also, there was a threat of job among people here. We had a number of smart, competent and productive people who came here to work onsite and they were well accepted in the team but the offshore part of the work was not that effective. We had challenges duplicating problems offshore either because of lack of knowledge or because of the right equipment. We did have some new development offshore but our environment is very fast and – specs change and evolve, very dynamic market, and our plans change. Because the requirements were not well-defined and specific, we found it very difficult to do offshore work. Also, the management at Excel was not open to trading off time to market with quality. So, we found it difficult to work offshore.*
>
> *We have been quite successful with the codec work that we started offshore in 2002. We have a strong team of 30 people developing codecs for various formats. This work has very well-defined specs; the technology and algorithms across codecs is common. Our people here would write specs and define milestones – performance, functionality and quality. This has been very, very successful, kind of a codec factory if you will. It takes a very specific knowledge to this work and the offshore team is very capable to do this kind of work.*

6.7.4 Offshoring of R&D and Pentagon's Innovative Capability

This section presents findings related to (a) generation of innovation by Excel for Pentagon and (b) transfer of knowledge from Excel to Pentagon.

6.7.4.1 Innovation Generation by Excel for Pentagon

The nature of the work Excel performs for Pentagon is technically intensive and while the tasks are quite innovative in nature, there is hardly any example of innovation that Excel has contributed to Pentagon. Interviews with Pentagon managers suggest that they do not expect Excel to contribute any product innovations, and as such the allocation of work is done accordingly. However, the managers at Pentagon recognize the engineering contributions made by Excel teams and acknowledge that those have helped address the time to market needs. Consider the observations made by the Manager for Codec R&D at Pentagon:

> *I can't under estimate the codec contribution. At Pentagon, Excel guys are taking backseat development and implementation role. They don't have the domain experience to define new products and features, etc. We are using Excel to accelerate development cycle to address the time to market. They have made significant contributions on this front and helped us bring a number of codecs into our product lines. High speed, high quality video codecs developed by Excel give us competitive edge. This is particularly significant because with Excel' help we made a transition from hardware codecs to software codecs platforms, which was a big hole in our product line. The Excel team also helped address key hardware design issues.*

Pentagon has a small team that carries out the necessary research for new codecs and develops their design specifications for the video products. The team at Excel develops and optimizes codecs for different media formats like MPEG4, JPEG, etc. for Pentagon. As a matter of fact, the Excel team wrote the fastest codec on a desktop platform for Pentagon's high definition media product, which could encode and decode more number of frames per unit of time. Also, Excel developed Codec Manager – a common platform that matches media format to applications. Using this platform, the codec team at Excel developed 11 codecs with 50% common code base without compromising quality. It also improved speed of development and porting to different platforms, and brought down the time for development of individual codecs from 11 months to 4 months. The idea for the Codec Manager was jointly conceived but designed and implemented by the team at Excel.

However, every Pentagon manager that I spoke to expected Excel to contribute process innovations, given its software process capability assessed at SW-CMM Level 5, and expressed their disappointment. According to the Vice President of Software Development at Pentagon:

> *Process innovation is an area where I think Excel could have really helped but did not. I am disappointed with Excel on their contributions on the process innovations front. At Pentagon, the development process is very loose. Excel being a Level 5 company, I expect them to bring in certain amount of process discipline to Pentagon. Instead, they adapted to Pentagon environment. No code review here, none there; no formal requirements documents here, none at Excel also. I think good processes are critical to guarantee product success.*

Commenting on Excel' contributions towards Pentagon's need for innovation, the Engineering Manager for Broadcast Server product at Pentagon observed:

> *We expected Excel to contribute new ideas and better approaches for development, but we have not seen much. I don't know if it is experience or anything else, or hesitation to put forward ideas! I have not seen innovative ideas…something that we had not thought about. But, of course, there are a number of examples of performance improvements and creative solutions. I don't think we will call that innovation; we could do it ourselves if we had resources. I have not seen any new products or extensions to existing product enhancement ideas. I have not seen any process improvement either. Maybe, we have not asked them to innovate; we have asked them to do very specific jobs. But they have done a good job of what they do. Also, in the codec area, I think they have done some innovative work.*

Managers at Pentagon unequivocally acknowledge that when R&D is outsourced to Excel, valuable resources in North America are freed-up to work on advanced features, new ideas, or next generation products. They also acknowledge the quality of the engineering work they receive from Excel and that it helps them address the time to market challenges. Experimental implementations…A Manager for Software Development at Pentagon whom I interviewed observed:

> *By offshoring R&D to Excel, I can augment staff in a more cost effective way. You also might get skill sets that might be difficult to hire otherwise. But I found the time zone differences particularly useful. It allows us to run a second shift, although sometimes it can also get in your way. However, the way we did things, we got a lot more coverage. For example, we would send an email asking to investigate something in the evening and by the time I come back next morning, I already have an answer. So, it affords us a round-*

> *the-clock coverage. It worked for us that way. It helped us get 18 hours coverage.*

During the course of my conversations with people at Excel, I, however, found that Excel had indeed contributed a major innovation for Pentagon, which was confirmed by Pentagon's Vice President for Software Development and the concerned Engineering Director upon probing deeply. This innovation pertained to Pentagon's broadcast server product. Pentagon has traditionally been a post-production media products company and in order to enter into the production market, in 2003 it acquired a company that had a media broadcast server product. Soon after acquiring the product, the responsibility for maintaining and enhancing it was entrusted to Excel. This product used hardware codecs and a motherboard manufactured by a leading Japanese manufacturer. A few months later, the Japanese manufacturer, however, announced its plan to stop production of the hardware card. This announcement obviously affected Pentagon because the broadcast server, even though expensive, was a major money-making instrument. As a result, discussions were ongoing within Pentagon to develop an equivalent but cheaper product that would also preferably eliminate any third-party dependencies. A technical lead from Excel proposed to Pentagon that Excel could help develop a low cost replacement product on the PC platform using off-the-shelf components. This got Pentagon management interested and they asked Excel to submit a proposal.

Excel proposed to develop a prototype in 3 months with 4 people, and the proposal was approved by the concerned Product Management Director at Pentagon. And, despite the fact that Excel did not have the domain experience and proximity to the market, it nevertheless successfully demonstrated a prototype and eventually developed the complete project. The project not only required software development work but hardware R&D as well. Pentagon also had a hardware team that was not happy with the fact that Excel was doing hardware work. There were personality clashes and the project went into a tailspin. The product was delayed significantly and from prototype to the availability of the actual product full 18 months had elapsed. The proposed development cost had fitted the budget but the delay had consumed considerable amount of the bandwidth of the Pentagon managers who had to closely work through the completion of the project.

However, what is noteworthy is that the design that Excel engineers conceived led to a competitive product that has generated substantial revenue for Pentagon. As opposed to the earlier version of the video broadcast server product, which cost US $80000, the replacement version cost just US $8000. Also, even though the new version did not apparently use any new technology, its conception was novel and it had several improved features. For example, in the new video broadcast server the media would become available as soon as recording was completed, which eliminated the need for certain hardware and thus reduced cost and at the same time improved the workflow. A feature was also integrated that would permit simultaneous recording and storage of the media. Also, the hardware codecs were eliminated and replaced by software codecs, which provided increased flexibility and improved performance. Moreover, Excel engineers also built-in support for certain drivers in the special open source operating system that the product used.

Even though it appears that some of the ideas for the conception of the replacement broadcast server product came from Pentagon's product management organization, designing the product was nevertheless quite challenging. The replacement product involved real-time data streaming besides transition from a proprietary to a standard, off-the-shelf platform. The idea of software codecs came from Excel, which were also less costly because it did not involve any royalties for chips and also permitted easy product reconfigurations. In addition, the acquired video broadcast server product came with no documentation or annotations for nearly 1 million lines of code, which the Excel team had to decipher to sustain the product and come up with its replacement version.

6.7.4.2 Knowledge Transfer from Excel to Pentagon

Engineers at Excel explicitly acknowledge that in working with Pentagon, they have acquired valuable learning and domain knowledge. However, the reverse learning and knowledge integration from Excel to Pentagon does not seem to be an outcome that has materialized as part of the engagement. In general, learning and knowledge integration does not seem to be an objective for Pentagon, as its Director of Engineering observed:

> *The Excel team provides us additional bandwidth so that we can focus on other crucial things. However, we do not really have a very strong knowledge or capability dependency on Excel even though many pieces of the product development activities are happening there. We retain the necessary knowledge for the work with us.*

Several people that I spoke to at Excel seemed to suggest that they did not possess any special knowledge that Pentagon would be keen to learn from them. Pentagon did hope to learn from Excel in the area of development processes but according to the company's Vice President for Software Development, this intent was affected partly by their own lack of openness. However, the interviews reveal that there have been specific instances when Pentagon systematically engaged in the process of learning and knowledge integration. For example, during the development of the new broadcast server the Excel team developed new knowledge and capability related to an advanced operating system. While the newly developed knowledge was integrated into the broadcast server product as a feature, Pentagon also hired people with skills in that particular operating system and systematically transferred the knowledge over an 8-month period. Similarly, when the project control for the new broadcast server was taken over by Pentagon, a systematic transfer of knowledge took place. So, it appears that whenever a piece of knowledge foreign to the Pentagon team was involved, Excel was called upon to systematically transfer the knowledge to Pentagon. In view of Excel's Senior Project Manager for Pentagon engagement:

> *Pentagon felt that all the knowledge pertaining to both old and new versions of the broadcast server was in Excel. Earlier, Excel had transitioned all the knowledge for the broadcast server from the company Pentagon had acquired. And, later, Excel created a new version of the broadcast server. So really speaking, most of the broadcast server knowledge resided in Excel, and Pentagon did not want any risk with the entire broadcast server knowledge being with us. So, they initiated a systematic knowledge transfer exercise.*

Due to the close interactions between Pentagon and Excel on a regular basis, frequent formal as well as informal communications take place between the team members across the ocean. As a result, a lot of ideas are exchanged and proposals discussed. Also, as part of its deliverables to Pentagon, Excel prepares extensive documentations, which capture the codified knowledge. Of course, a lot of knowledge integration takes place through embededdness in products and components, but perhaps the value perception associated with these is not very high because of the familiarity of the Pentagon team members with these knowledge domains.

6.7.5 Offshoring of R&D and Pentagon's Organizational Flexibility

Flexibility is very crucial for Pentagon's competitiveness. Its competitors frequently introduce new products with improved price-performance ratio and new features, and new competitors emerge every now and then due to technological convergence. Pentagon needs to make its products available for different computer platforms and operating systems and make sure its products are interoperable with other products so as to meet the rising demand for integrated workflow. Gaining flexibility through offshore R&D outsourcing is, therefore, a strategic intent for Pentagon.

Pentagon's primary objective in engaging Excel is to access well-qualified technical resources in a flexible manner. Indeed, the interviews suggest that the Pentagon managers leverage offshore R&D outsourcing to derive two types of flexibility: to be able to ramp up and ramp down resources in accordance with emerging needs and to reduce fixed costs. In addition, they also leverage offshore R&D outsourcing for performing some of the non-core work or product sustenance work so that their resources can focus on more strategic and futuristic activities.

Most Pentagon managers that I interviewed said that Excel teams were quite adaptive in picking up new technologies, and by working with Excel they could gain access to a versatile technical skill pool to fulfill their needs for deploying different technological capabilities. They also felt that the arrangement with Excel helps them to address the time to market objectives besides permitting its own R&D staff to focus on strategic programs. In their opinion, a relationship is valuable than having contract employees. Moreover, an offshore R&D outsourcing arrangement frees Pentagon from having to worry about career progression or development and learning of the engineers.

Pentagon's Vice President for Software Development explained how to they leverage their engagement with Excel to gain organizational flexibility:

> *Flexibility is very important for Pentagon. We need certain bandwidth to explore new areas and technologies and yet be able to continue to maintain current product lines. Excel sustains our existing products whereas my resources work on future technologies and next generation products. The relationship with Excel also aids our ability to take on more custom work, which is crucial for our market acceptance and revenue growth.*

6.7.6 Impressions from Pentagon – Excel Offshore R&D Outsourcing Case

The engagement between Pentagon and Excel represents a classic case where the main drivers for offshore R&D outsourcing are access to low cost talent pool without any explicit emphasis on innovation and learning. The search for operational efficiency and flexibility form the strategic intent for offshoring of R&D. The concern for intellectual property protection and overdependence on the outsourcing partner influence work allocation, as also risk of failure. Pentagon allocates very well-defined R&D activities to Excel that require generic technical skills. And, even when intensive technical work is involved, as is the case with codec development, alternate market options readily exist although at a cost. According to Excel' Group Project Manager who oversees the Pentagon engagement:

> *Codecs are quite commoditized products. There are several third party vendors who supply codecs. However, buying codecs from the vendors involves royalty payments and there are usually performance and support issues. So, while in-house development may be preferred, several alternate market options exist.*

The interviews reveal that an offshore R&D outsourcing arrangement allows a firm to squeeze more (commitment) out of a partner because of the lure of additional business and through enforcement of the service level agreements (SLAs). Quick access to versatile technical capabilities at no fixed cost is an added advantage for enhancing both innovative capability and capacity.

The case also offers insights for organization of high technology R&D. For example, what kind of R&D work should ideally be transferred and when R&D effectiveness may be compromised. As the Pentagon—Excel offshore R&D engagement suggests, often the availability of an appropriate laboratory infrastructure may be essential for R&D effectiveness and its absence could compromise the capability leverage that might otherwise exist.

The conversation with Pentagon's Vice President for Software Development also surfaced an interesting insight about social support infrastructure can augment team performance. He observed:

> *I think where Excel excels is in providing support infrastructure for new team members. There, the environment is very collaborative. In the U.S. type development organization, it is more one-to-one, not so much collaborative effort. So, even if the Excel team members lack the technical depth and domain understanding, their social support infrastructure makes up for that.*

The case also highlights another crucial point: That in offshore R&D outsourcing engagements alignment of the business models and objectives is necessary for obtaining maximum leverage. While Pentagon requires highly qualified resources with in-depth technical knowledge who can continue to be part of its R&D projects, Excel has a compelling need to move its resources around so as to optimally operate its business model. This misalignment is further accentuated by Pentagon's inability to commit a sizable business for a longer term. For a tighter alignment, a risk-reward model must be installed. Finally, the Pentagon-Excel case shows how innovation 'thinking' and 'doing' can be segregated in an offshore R&D outsourcing arrangement while gaining organizational flexibility and R&D efficiency.

6.8 CASE STUDY VIII: INTEGRATED SECURITY SOLUTIONS

This case study pertains to the offshore R&D outsourcing engagement between Integrated Security Solutions (ISS) and Leading Technologies Labs (LTL).

6.8.1 Background and Context

ISS is a diversified, multi-technology Fortune 500 company headquartered in North America. It employs more than 150000 employees spread around the globe, and manufactures high technology products for a range of industries. ISS's 2006 annual revenue was in excess of US $30 billion, nearly 3% of which was spent on R&D. LTL is an eight years old India-based R&D services company with 2006 annual revenue in excess of US $100 million and an employee base of about 1200 people. LTL provides a range of R&D services to clients globally in various high technology sectors. It also develops and licenses its own intellectual property, and is known for having created several innovations for its clients. ISS has had an offshore R&D outsourcing relationship with LTL since 2003 and engages LTL for carrying out several R&D projects varying in size, scope, duration, and complexity. As of October 2005, LTL was engaged in five R&D projects for ISS with a total team size of 120 people, all based in India.

One of ISS's business divisions with 2006 annual revenue in excess of US $3 billion is focused on providing a range of advanced security solutions to enterprises. ISS's security solutions include both physical security solutions and solutions for electronic network security and surveillance. Competitive success in security solutions business depends on a rich portfolio of products, ability to incorporate technological advancements and sell integrated solutions, and importantly, high product reliability and performance. Compatibility with existing products and systems, and integration of diverse functions into a single product are of critical importance for marketplace success. Moreover, the cost of products is also a significant determinant for success. Due to the emergence of a host of digital technologies, the security solutions sector has witnessed an intensification of technology-based competition. Explaining the evolving security and surveillance market landscape and ISS's emerging competitive priorities, its engineering director observed:

> *In our market, earlier there were different modalities like alarm, video, access, etc., but now integrating these on a single platform at low cost structures is important. So, the idea is to have a single platform and exploit that for different market segments. Our products are pretty complex but the technologies underlying them are quite simple. We develop for worldwide markets, and so we need to incorporate several regulatory requirements. We have enjoyed good financial success but have been laggards in terms of time to market.*

During October 2005 and February 2006, I interviewed several people at LTL and ISS to study one particular R&D project in-depth, which employed 50 R&D engineers at LTL and delivered a major product innovation in the area of security and surveillance technology. Table 6.9 shows the details of the interviews that provided data for this case study.

6.8.2 Offshoring of R&D by ISS

In 2003, ISS acquired a North America based security technologies company, VT, to complement and expand its product portfolio. VT had a PC-based digital remote

Table 6.9: Details of the Interviews Conducted at ISS and LTL

#	Position/Role	Location	Date of Interview	Mode of Interview
1	Director, R&D Services ISS Account, LTL	India	October 27, 2005	Face-to-Face
2	Technical Manager ISS Account, LTL	India	October 27, 2005	Face-to-Face
3	Project Manager ISS DSS Project, LTL	India	October 27, 2005	Face-to-Face
4	Technical Architect ISS DSS Project, LTL	India	October 27, 2005	Face-to-Face
5	Development Manager ISS DSS Project, LTL	India	October 27, 2005	Face-to-Face
6	Engineering Manager, ISS	U.S.A.	January 27, 2006	Telephone
7	Engineering Director, ISS	U.S.A.	February 2, 2006	Telephone
8	Product Architect, ISS	U.S.A.	February 5, 2006	Telephone

surveillance system, which had advanced features for capturing, processing, and streaming video, associated with an alarm. However, ISS wanted the product re-designed as an embedded system and move away from the PC platform for reasons of performance and reliability. So, soon after the acquisition of VT, ISS approached LTL and asked for a proposal for carrying out the re-design of the digital surveillance product as an embedded system. ISS provided a broad set of requirements to LTL for the purpose of proposal development and also specified the cost target.

LTL's proven software process capabilities (SW-CMM Level 5) as well as hardware R&D capabilities combined with its low cost structures influenced ISS's decision to explore engaging LTL and ask for a proposal. ISS's Engineering Manager responsible for the Digital Video Security and Surveillance Product, who is also tasked with managing the relationship with LTL, explained how the decision to engage LTL on the project came about:

> *Due to budgetary constraints, we had a limited ability to hire R&D staff and grow organically. Moreover, we had far more work than we could do. Outsourcing offered a simple and inexpensive way to expand the team. Also, we needed some capabilities that we did not have, and with complementary capabilities we could explore new avenues. Plus, of course, the cost factor – with the same budget, we could have more people working on our objectives at LTL.*

LTL had not worked on such a product earlier. However, by that time, its relationship with ISS was already two years old and as a result, teams at LTL were familiar with

ISS's product development process – a stage-gate system with five gates, covering activities starting from opportunity detection to product launch. Moreover, by that time, LTL had already successfully carried out a large R&D project for ISS, due to which ISS held LTL in high regard. LTL responded to ISS by submitting a proposal that outlined a three-phase approach – an initial, onsite requirements capture phase, a prototype development phase, followed by the actual full product development phase. The proposal elaborated in detail as to why such a phased approach was necessary to develop the product.

The main challenge involved developing an optimal embedded system design while meeting the specifications and achieving the cost target. ISS found the proposal appealing and decided to award the R&D work for developing an embedded system version of the PC-based digital surveillance system to LTL. The application development responsibility remained within VT – the company ISS acquired, for reasons of intellectual property. Moreover, because of VT's prior work in the area, they possessed the necessary domain knowledge whereas LTL had no experience in the area.

The three-phase R&D project started with a four-week onsite requirements capture phase in September 2004. During this phase, LTL engineers travelled to ISS's facilities in North America to interact with its R&D staff and collaboratively captured requirements for the product to be developed. Following this, LTL R&D engineers developed a product architecture, which was reviewed and approved by ISS in November 2004. LTL commenced the actual product development in January 2005 with a team of 50 engineers and delivered the first prototype in August 2005. The final product was successfully delivered to ISS in February 2006. The scope of R&D activities at LTL included embedded software R&D, hardware R&D, firmware development as well as mechanical systems design. In accomplishing the project objectives, LTL also interfaced with several external semiconductor vendors.

6.8.3 Organization and Management of Offshore R&D by ISS

This section provides an account of the organization and management processes ISS employs for its offshore R&D engagement with LTL. Specifically, the structural characteristics, relational characteristics, and R&D task allocation practices associated with the engagement are described.

6.8.3.1 Structural Characteristics

The R&D activities for the project were carried out at LTL in close collaboration with the engineering team at ISS. This project, like all other ISS projects being done at LTL, was governed by a 'master service agreement' that set forth the terms and conditions for the engagement and specified the financials. Under the umbrella of the master service agreement, different ISS business divisions would engage LTL for various

R&D projects. Thus, the approach for R&D project management varied from project to project, depending on the business division and the nature of the R&D work. Figure 6.15 depicts the governance structure applicable to the digital video security and surveillance product R&D activities performed at LTL.

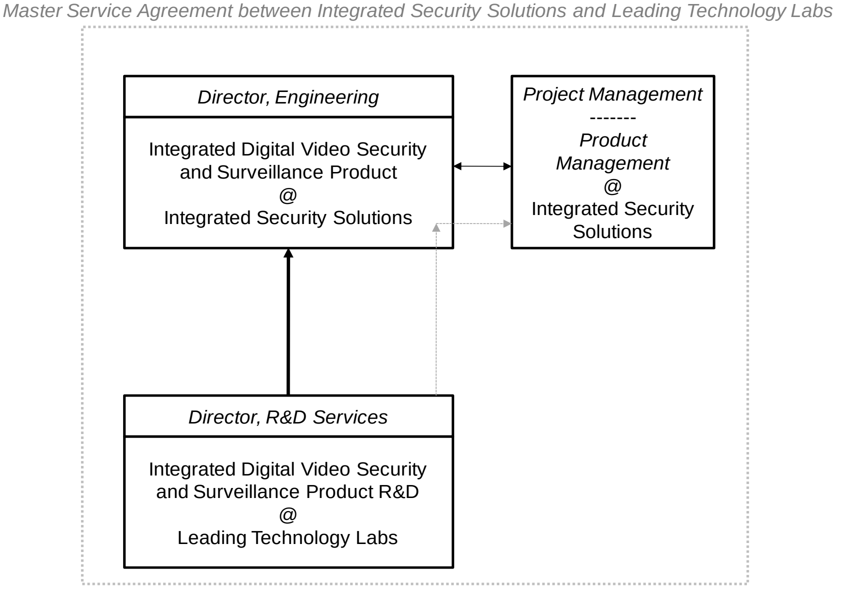


Figure 6.15: Organization and Governance Structure for ISS' Offshore R&D Outsourcing Engagement with LTL

The R&D project team, led by one of LTL's director for R&D services, directly reported into, and closely interacted with, the engineering organization responsible for the security and surveillance product at ISS. The teams at LTL received all specifications and information from the engineering department at ISS; they did not have any direct interface with the project management or the product release functions. Although the ISS engineering manager, who was responsible for the relationship with LTL, would supply specifications and provide cost and schedule targets, the two teams would often hold deliberations and agree on a 'negotiated' set of targets. A team of architects at ISS developed product specifications but the solution architecture was evolved collaboratively. The domain knowledge for the R&D activity came from ISS since LTL had no prior experience or background in the area.

6.8.3.2 Relational Characteristics

The relationship between LTL and ISS, as seen in the particular context of the security and surveillance R&D project, is characterized by high trust, openness, and mutual respect for each other. All the interviews suggest a collaborative modus operandi in use. The LTL team is seamlessly integrated with the ISS as an extension of their engineering team and participates in the product roadmapping exercise as well as decision-making processes concerning the product. At LTL, the management emphasizes and practices complete transparency, as highlighted by the director of R&D services at LTL:

> *We have been very transparent about the problems we were facing or foreseeing during the work. We would propose alternate designs or approaches to address the challenges, and so we would have constant dialogues with them. If we think we cannot meet the schedule or performance requirements, we openly inform them and also share what we are doing to address that.*

All the three executives that I interviewed at ISS attest this. Also, the team at LTL feels fully integrated into ISS, as suggested by LTL's technical architect for the project:

> *In my view, this is a case of internalization of R&D. When they outsource, they actually internalize teams. Even though I work for LTL, for the duration of the project I actually work for the customer and so my goals are customer's goals. Of course, there would be LTL goals like team management, efficiency and productivity, but we need to tie these to what are crucial for customer success.*

The ISS executives appeared very satisfied with the contributions and commitment of the LTL team members towards the project, as is evident from the following observations of ISS's engineering manager responsible for managing the interface with LTL:

> *We define requirements and set price targets, and LTL has done a very good job on this front. If LTL had failed to address the price targets, we would have pulled out from the relationship because cost is an important factor for us. As the project has evolved, LTL gained a good understanding of the total solution and market, and made some good value added contributions to functionality. In fact, they gave us a new design. LTL helped us improve time to market, which we ourselves could not address due to our limited size. With LTL, we are able to do more simultaneously.*

The interviews revealed the ISS executives had considerable appreciation for both LTL's R&D performance and the approach to serving clients. As a matter of fact, in 2006, ISS awarded a rating of 5/5 to LTL on its annual customer satisfaction survey for the project.

6.8.3.3 R&D Task Allocation

ISS follows a project-based engagement model. Such an approach stems from their need to access R&D talent on-demand at low cost, without incurring any fixed costs, or to rapidly acquire complementary and diverse technical skills. The Engineering Director I interviewed at ISS described the dominant philosophy used to engage and allocate work to LTL:

> *We do not expect LTL to contribute major design breakthroughs or push the boundaries of R&D, or to introduce new product features. We give them pretty well-defined tasks and expect them to execute those for us. We set forth a clear set of expectations. We always give them a recipe on how we want them to do it. And, we don't get any major or radical innovation because everything is so well laid out in the program. We are the domain experts, and so we don't look to LTL to push us forward on this front.*

Clearly, as the above quote suggests, ISS's motivation in engaging LTL is to access qualified resources at low cost to execute well-defined engineering projects. For the digital video security and surveillance system project, ISS engaged LTL under the aegis of the master service agreement that existed between the two companies. However, the engagement approach for this project differed from the more 'regular' projects because of the complexities involved. The digital video security and surveillance system project involved a multitude of technologies, ranging from video capture and processing in association with alarms to data storage, processing, and streaming capabilities to networking and remote surveillance. So, unlike the other projects, where the R&D activities were simply contracted out, ISS asked LTL to submit a proposal to gage their ability for the digital video security and surveillance system project. The proposal served as confidence boosting measure and only after the ISS director and architect were convinced about LTL's ability to deliver on the project, the work was awarded to LTL.

The allocation of work by ISS to LTL was sort of 'boxed' and the responsibilities were clearly segregated. First, LTL was assigned the R&D work only for platform design, and all the application work that required domain knowledge remained with VT – the company ISS acquired. Second, the broad specifications for the product and its targeted cost and price points were clearly specified by ISS up front. However, LTL was not imposed any architectural design or was not mandated to use any specific technologies.

The necessary domain know-how was supplied to LTL by ISS. The project engagement model also required LTL to validate the major outputs with ISS; for example, architecture design, product prototype, etc.

6.8.4 Offshoring of R&D and ISS's Innovative Capability

This section presents findings related to (a) generation of innovation by LTL for ISS and (b) transfer of knowledge from LTL to ISS.

6.8.4.1 Innovation Generation by LTL for ISS

When ISS engaged LTL for the digital security and surveillance product R&D, it specified the product requirements, including the performance parameters, and set the product cost target. However, capturing detailed requirements for product development was a rather complex task and was accomplished by a collaborative effort between LTL and ISS R&D engineers. What began as a 3-page specification document made available by ISS culminated into a 40-page product requirement document prepared by LTL after the onsite requirements capture phase. According to LTL's Technical Architect associated with R&D activities for the digital security and surveillance product:

> *We got the gene of the product but had to stitch cells, flesh, and bones to give shape to what the product will look like – the complete body. Nearly 30% additional features were contributed by us as value added.*

ISS's engineering team had a solution in mind for developing an embedded system version of the digital security and surveillance product. And, so, that's a seed LTL R&D teams received from ISS. However, the envisioned product had many engineering constraints. Team members at LTL also did an extensive competitor analysis, which imposed further constraints for the product design. Also, the product being an audio-visual product with audio-video storage, networking, etc. added to the complexity of the design task. So, the LTL team focused on understanding and resolving the constraints while closely interacting with ISS engineering team. The LTL team also strived to gain an understanding of the manufacturing and production processes used by ISS. LTL successfully delivered the product on schedule while meeting the performance and reliability specifications.

What is noteworthy is that during the course of the project LTL contributed a major innovation to ISS. VT's original PC-based digital surveillance system catered to the different variants of the product but fell short of performance and reliability criteria vis-à-vis competitors. However, the technological shift to embedded systems would require creating an embedded system version for each variant of the product. The product had 6 variants that catered to various segments of the market. Although ISS knew that an embedded system version of the product would require a separate integrated circuit board for each variant and that this would have implications for production costs, it nevertheless saw an overall merit in making the transition to embedded system technology. However, LTL surprised ISS by developing a single low-cost, high performance embedded system platform for the digital surveillance system that would be scalable and flexible, and allow for production of the multiple product variants in a plug-and-play fashion. The modular platform that LTL developed implied significant impacts on production costs and inventory management because it would facilitate just-in-time (JIT) configuration of the product variants.

The modular, plug-and-play embedded system product platform LTL designed was considered a major architectural breakthrough by ISS, especially considering the aggressive cost/performance targets that ISS had set for itself for the competitive positioning of the product. The platform had only one integrated circuit board, and required changes only in the firmware for creation of the product variants. Interestingly, LTL also designed a feature by which the required firmware upgrade could be done remotely. As a matter of fact, LTL had worked with a number of semiconductor vendors and provided to ISS multiple architectural design options to choose from so that ISS could determine an optimal cost/performance combination for itself. The architecture was finalized through a collaborative process in which ISS's R&D staff actively participated and brought in the necessary domain perspectives. This innovative platform design improved ISS's bottom line and led to new market opportunities for it. Moreover, the product won an award at a major international trade show, and the new platform resulted in a patent for ISS.

Of course, this was something ISS had desired but not necessarily expected LTL to contribute. The innovation from LTL came as a pleasant surprise to ISS, as captured by the following remarks of the Engineering Manager at ISS:

> *On this project, LTL offered a solution that was better, cheaper and more advanced – something that we had not thought about ourselves. They deployed their technological understanding and leveraged their skills to propose a superior solution. They presented a solution that was elegant and advanced. New design idea that helped a great deal. It was a nice surprise for us. With a single, modular platform design that they developed, product variants can be soft configured flexibly and easily.*

The people I interviewed at LTL said that they were challenged by the project's requirements, which resulted in the initiative they took to look for an optimal design that will meet both the performance and cost targets. They also attributed the innovative outcome to the collaborative involvement of their client – ISS. They also believed that the constraints imposed on the project served as an impetus for innovation. The technical lead for the digital security and surveillance R&D project at LTL observed:

> *When cost is a limiting factor, innovation is an imperative.*

According to the Engineering Director responsible for the product at ISS:

> *People at LTL are technically very good who could see beyond the specifications. They also took the initiative to propose design options. Even though the teams were removed from the markets and customers and did not have the domain knowledge, they understood the scalability requirement. Plus, a good description from us on the requirements, which led to the system innovation. Also, because they are such experts in their area, they could innovate. They are smart people and have excellent technical knowledge.*

6.8.4.2 Knowledge Transfer from LTL to ISS

In R&D outsourcing when the engagement model employed is project-based, the project and its deliverables serve as the vehicle for learning and knowledge integration. This project was no exception. Due to the collaborative nature of the project organization, close interaction between ISS and LTL resulted in constant exchange of ideas and learning for ISS. Regular formal status reviews and informal communications between the teams across locations served as channels for learning and knowledge exchange. LTL also brought to bear the learning from the other outsourcing projects that it had done for its other clients, and this, in turn, allowed ISS to gain new perspectives and insights. The interviews with ISS executives indicated that they were open to learning from LTL, and this actually facilitated the learning and ideas exchange during the project. According to ISS's Engineering Manager:

> *Our technical capabilities have grown. We feel more comfortable with new technologies that we never worked on before. Their inputs on technical solutions help enrich our learning, which we have tried to incorporate in our practices.*

However, the major learning and knowledge integration for ISS took place by way of project artifacts and deliverables. To start with, the ISS executives readily acknowledge that each of the design alternatives that LTL had proposed and documented was a major source of new learning and knowledge for them, both from architectural and technological points of view. More importantly, learning and knowledge integration took place for ISS by way of the product development itself because the delivered product actually embedded the valuable learning and knowledge generated during the course of R&D. Furthermore, due to LTL's emphasis on a process-centric approach, each phase of the R&D project was accompanied by extensive documentation which served as a repository of codified knowledge for ISS. Finally, as part of its R&D processes, LTL also did a formal technology transfer to ISS by training its engineering and technical support staff on the new platform and provided relevant documentation.

6.8.5 Offshoring of R&D and ISS' Organizational Flexibility

The Securities Technologies Division of ISS does not face any major technological and market uncertainties and, therefore, the need for strategic adaptation as such is not very high. However, due to the global outreach of its business, ISS often receives a multitude of customer requirements that it cannot simultaneously address because of resource constraints. So, while the plug-and-play product design that LTL produced allowed ISS to create product variants quickly, an offshore R&D outsourcing relationship with LTL permitted ISS to access qualified technical resource pool on-demand at low cost to boost its R&D capacity. In the words of the Engineering Director at ISS:

> *We work for worldwide markets and are often faced with competing priorities. We need to adapt to changing customer requirements and our relationship with LTL helps us address this need.*

The speedy and flexible low-cost resource mobilization permits ISS to lower its fixed costs in R&D while addressing multiple market opportunities simultaneously. However, the relationship with LTL also allows ISS to gain access to technological diversity, which may be vital for its competitiveness. For example, in the case of the integrated digital security and surveillance solution, ISS engaged LTL for embedded systems capability, which it did not apparently possess and did not want to develop.

6.8.6 Impressions from ISS-LTL Offshore R&D Outsourcing Case

The case of offshore R&D outsourcing engagement between ISS and LTL offers several interesting insights despite its reliance on a project-based engagement model. The case suggests that an 'inclusive' and collaborative modus operandi results in a closer integration of the geographically dispersed teams and promotes frequent information and ideas exchange besides building commitment of the remote team members. It appears that inclusivity breeds commitment, which in turn catalyzes initiatives. The case also signifies 'boxed innovation,' where the boundaries of the innovation are pre-determined with imposition of performance requirements and constraints. As the case of the digital security and surveillance product shows, constraints can challenge R&D teams and catalyze creative thinking, which in turn results in valuable innovation. Moreover, as the case suggests, the product platform design innovation came about for ISS through an orchestrated approach which systematically segregated R&D responsibilities by technological and domain capabilities and exploited complementarities offered by the outsourcing partner.

Although it would be inappropriate to conclude based on a single instance, the case also suggests that by leveraging an R&D outsourcing partner, a large, long-established firm can overcome the familiarity trap and achieve fundamental innovations. In the words of LTL's Technical Architect for ISS's digital security and surveillance product R&D project:

> *LTL gave ISS access to a different, fresh mindset. ISS might have sown the seed but the soil at LTL is different. So, depending on the soil, how the same tree actually grows, could be different.*

Depending on how the relationship is nurtured, an offshore R&D outsourcing engagement can result in more than just cost savings and access to engineering talent and can actually help a firm push forward its innovation agenda. Since projects are temporary organizations, learning and knowledge integration in an offshore R&D outsourcing project really depends on the degree of integration, inclusivity and collaboration, which may facilitate or prohibit interaction and exchange. However, in a project-based engagement, the real assimilation of learning and integration of knowledge happens through the project deliverables and process artifacts. The product embeds the learning and knowledge, whereas the process artifacts such as design proposals and product validation review documents capture the vital knowledge. The low cost and scalable resource pool that an R&D outsourcing vendor offers can permit a speedy and innovative bundling of diverse resources for a high technology firm. This also permits a firm like ISS to gain cognitive flexibility and overcome the familiarity trap that plays out due to its administrative heritage.

Finally, it is worth paying attention to what ISS's Engineering Manager had to observe about the organization of global R&D activities:

> *At the project level, the back-and-forth information flow, I think, adds more cycle time, especially when the need for interaction is high. If people are co-located, what could be a one day delay in an offshore set-up due to time zone difference could be done in five minutes. Not having people co-located really does impact your ability to react and achieve alignment on issues and priorities. Separation results in communication gap and misunderstanding. It can still happen locally but happens a lot less. We don't really account for the time delay aspect of the communication that exists.*

This observation suggests that in partitioning innovative tasks for offshore R&D attention must be paid to minimize the need for interactions between locations. ISS achieved this by partitioning the innovation project into technological capability and domain capability, or platform design and application development. However, this also gives rise to a paradox: reduced interaction between locations would affect the potential for learning, which is typically an objective in R&D globalization. If the globally dispersed knowledge cannot be integrated and assimilated into the corporate memory, then it can potentially limit a firm's innovative capability. On the other hand, a greater dependency between globally distributed locations may facilitate greater interactions and knowledge flows but lead to higher coordination costs and cycle times.

End Notes

In studying the offshore R&D engagements, an interesting phenomenon as regards work culture came to the light. Interviews revealed that R&D engineers in India, unlike their counterparts in the U.S. and Europe, frequently leveraged their internal social networks for collaborative problem solving and performance of their tasks. Such a collaborative approach to work among R&D engineers in India leads to enactment of their collective capability and makes up for their relatively less work/product experience compared to overseas counterparts. A similar observation was shared by Pentagon's Vice President for Software Development based on his experience with offshore R&D outsourcing to Excel Technologies. According to him, "offshore R&D teams were able to make-up for their relatively less experience because of the collective experiences that is brought to bear in the offshore social structure".

CHAPTER 7
CROSS CASE ANALYSIS

THIS RESEARCH EMPLOYED a multiple case study approach to generate a descriptive and explanatory understanding of the link between offshoring of R&D and the firm's innovative capability and organizational flexibility. The objective of this chapter is to present the cross-case analysis of the case studies described in Chapter 6. First, the findings from the individual case studies are reflected on the conceptual lens described in Chapter 4. Reflecting on different dimensions of the conceptual lens, tabular displays are included to summarize the findings from the case studies. Then, the similarities and differences across cases are identified to develop an interpretive understanding of the phenomenon and its focal aspects. In addition, interrelationships between various dimensions of the conceptual lens and their influence on the focal aspects of the phenomenon of offshoring of R&D—innovative capability and organizational flexibility—are investigated as part of the cross-case analysis. Based on the cross-case analysis, this chapter presents testable propositions and also discusses how the findings are related to the extant literature.

7.1 OFFSHORE R&D ENGAGEMENTS

This research employed a purposive sampling strategy to achieve maximum variation across cases. Thus, as shown in Table 7.1, the case studies varied in their contexts, covering many different industry sectors and companies having headquarters in different countries. Also, the size and tenure of the offshore R&D engagements examined in this research varied considerably. Moreover, the case studies covered both intra-firm and inter-firm offshore R&D engagements. Furthermore, as the research included companies headquartered in different countries, the source of the offshore R&D engagements also differed in their cultural contexts. However, one thing was common across all the offshore R&D engagements—the offshore R&D units were located in India.

Despite differences in the context of the offshore R&D engagements studied, several similarities are evident. First of all, all the offshore R&D engagements were established with the motive of improving R&D efficiency by accessing technical R&D resources available in India at low cost structures. The findings suggest that offshoring of R&D is a result of the interplay between two different motives: (a) gain R&D efficiency by accessing knowledge resources at low costs and (b) access large scale of technical R&D resources with diverse skills and knowledge to expand R&D capacity.

Table 7.1: Offshore R&D Engagements[1]

Case	Industry	Actors in the Engagement	Primary Motive in Offshoring R&D	Mode of Offshoring	Tenure of the Engagement	Size of Offshore R&D
VERITAS	Enterprise Software	VERITAS USA and VERITAS India	Access large scale of technical talent to expand R&D capacity	Intra-firm	11 Years	900 People
SAP	Enterprise Software	SAP Germany and SAP Labs India	Access large scale of technical talent to expand R&D resource base	Intra-firm	7 Years	3000 People
Universal Healthcare Systems	Medical Systems	UHS Europe and UHS India (R&D)	Leverage India talent pool to set-up a software competence center to cater to different product lines and groups	Intra-firm	8 Years	300 People
Cordys	Enterprise Software	Cordys, The Netherlands and Cordys (R&D) India	Access high quality technical resources at low cost	Intra-firm	4 Years	300 People

[1] Data as of date of visit to the respective case study site

Table 7.1: Offshore R&D Engagements[1] (…Continued)

Case	Industry	Actors in the Engagement	Primary Motive in Offshoring R&D	Mode of Offshoring	Tenure of the Engagement	Size of Offshore R&D
Globetronix	Consumer Electronics	Globetronix Europe and Globetronix India (R&D)	Leverage India talent pool to set-up a software competence center for different product lines	Intra-firm	10 Years	600 People
Frontier Technologies	Semiconductors	Frontier Technologies U.S.A. and Pervasive Technologies	Flexible access to technical resources at low cost structures; leverage complementary capability	Inter-firm	8 Years	330 People
Pentagon, Inc.	Media & Entertainment	Pentagon, U.S.A. and Excel Technologies India	Flexible access to technical resources at low cost structures	Inter-firm	5 Years	60 People
Integrated Security Solutions (ISS)	Security & Surveillance	ISS, U.S.A. and Leading Technologies, India	Access software R&D capability at low cost to reduce fixed R&D cost	Inter-firm	2 Years	50 People

[1] Data as of date of visit to the respective case study site

Reduction in fixed R&D costs was the main motivation for firms to engage in offshore R&D outsourcing, although in the case of Frontier Semiconductors access to the complementary capabilities of its outsourcing partner (Pervasive) was also an important consideration. Although the findings indicate that some offshore R&D engagements placed higher emphasis on cost reduction than access to R&D talent, both scale and cost of R&D talent together motivated offshoring of R&D.

7.2.1 Structural Characteristics

Table 7.2 displays the pattern of structural characteristics across offshore R&D engagements. In all the cases, the offshore R&D engagements resembled principal-agent relationship, where agents (offshore R&D units) received directions and R&D assignments from their principals (firm headquarters). In all the cases, the offshore R&D units carried out only some parts of R&D value chain activities on behalf of their respective firm headquarters. None of the offshore R&D units had any product-market mandate or ownership for any product or product lines. In all the cases, the budget and resource levels as well as the scope of R&D activities for the offshore R&D units were determined by firm headquarters. Also, no offshore R&D unit performed any activity that required or involved direct access to customers and markets.

In the cases of inter-firm offshore R&D engagements, a formal agreement or memorandum of understanding defined the 'contract' between the two parties, specifying the terms, conditions and provisions of the exchange relationship. The intra-firm offshore engagements, on the other hand, were structured based on an understanding between firm headquarters and offshore R&D units of the innovation tasks to be performed. In all the cases, written documents were used to specify the scope and outcome of the R&D tasks to be carried out by the offshore R&D units.

These findings show that the firms studied predominantly employed centralization and communication to coordinate offshore R&D activities. The firms also used formalization and socialization to varying degrees to coordinate offshore R&D engagements, although the use of socialization in inter-firm offshoring relationships was markedly low. High degree of centralization across all the offshore R&D engagements studied is in contrast with the received wisdom. Studies on R&D globalization have reported centralization to be inappropriate for coordination of global R&D units. According to the received wisdom, high degree of centralization hampers creativity and impacts the ability of global R&D units to produce innovative outputs (e.g., Ghoshal and Bartlett, 1988; Nohria and Ghoshal, 1997; Nobel and Birkinshaw, 1998; Persaud, *et. al.*, 2002). However, there are several reasons for high degree of centralization in management of offshore R&D.

Table 7.2: Structural Characteristics of Offshore R&D Engagements

Case	Structure of the Relationship with Offshore R&D Unit	Centralization	Formalization	Communication	Socialization
VERITAS	Principal – Agent (Intra-firm)	High	Moderate	High	Moderate
SAP	Principal – Agent (Intra-firm)	High	Low	High	Moderate
UHS	Principal – Agent (Intra-firm)	High	Moderate	High	Moderate
Cordys	Principal – Agent (Intra-firm)	High but Participative	Low	High	Moderate
Globetronix	Principal – Agent (Intra-firm)	High	Moderate	High	Moderate
Frontier	Principal – Agent (Inter-firm)	High	Moderate	High	Low
Pentagon	Principal – Agent (Inter-firm)	High	High	High	Moderate
ISS	Principal – Agent (Inter-firm)	High	Moderate	High	Low

First, since in all cases only parts of the R&D value chain activities are allocated to offshore R&D units, centralized orchestration of innovative activities becomes necessary for seamless global integration. Second, given the principal-agent relationship structure of offshore R&D engagements, centralization emerges as the coordination mechanism of choice because it allows the firm headquarters to exert behavioral control on offshore R&D units. Behavioral control ensures that offshore R&D units perform R&D activities in accordance with the expectations of firm headquarters, and also mitigates the potential negative effects of distance—reduced visibility into the activities of offshore R&D units. Third, given the emphasis on improving R&D efficiency through offshoring of R&D, efficient deployment of resources can be best achieved through high degree of centralization.

Interestingly, even though the degree of centralization was high across all the offshore R&D engagements, the case of Cordys differs from the rest of the cases in an important way. That is, Cordys employed participative centralization as opposed to absolute centralization (Fischer and Behrman, 1979) to coordinate and integrate its offshore R&D unit. Cordys indeed made all R&D decisions centrally but involved managers from its offshore R&D unit while determining the resource and budget levels, and, to some extent, the R&D programs. However, the cross-case analysis also reveals that almost all the offshore R&D units had the autonomy to make operational decisions that pertained to recruitment and development of their engineers.

Like centralization, even the use of formalization across all the offshore R&D engagements studied is in contrast with the received wisdom. Use of formalization for coordination of R&D activities is considered ineffective, and empirical studies have shown that formalization hampers creativity and innovative ability (Nohria and Ghoshal, 1997; Kim, *et. al.*, 2003). Nevertheless, the reason for the use of formalization in offshoring of R&D has to do with the distributed and interdependent nature of the task environments. As the case studies suggest, use of formal project plans clarified roles and responsibilities of distributed organizational actors, helped align their efforts, and identified the interdependencies between geographically dispersed actors. Similarly, standards and R&D process manuals provided a common terminology for the geographically and culturally distanced R&D teams and ensured consistency in interpretation of innovative activities and outputs. Finally, another reason for use of formalization in offshoring of R&D stems from the firm headquarters need to have visibility into the activities of the geographically distanced offshore R&D unit through formal reporting and review procedures.

The reason for low levels of formalization in the cases of SAP and Cordys had to do with the nature R&D tasks performed by their respective offshore R&D units. In the case of SAP, the R&D tasks performed at its offshore R&D unit did not have any interdependencies on any other location, and hence only some degree of behavioral control was exerted through formal reporting and review procedures. In the case of Cordys, almost all development activities were concentrated at its offshore R&D unit in India and as such there was no distribution of development tasks. Hence, the degree of formalization in the relationship between headquarters and the offshore R&D unit was low and confined only to routine project status updates and reviews with the headquarters. On the other hand, in the case of Pentagon, use of high degree of formalization can be attributed to the volume and criticality of its R&D activities being performed offshore. Pentagon operated in a highly dynamic market environment and, therefore, timely and successful completion of R&D programs was crucial for its performance. Moreover, Pentagon's offshore R&D unit was hosted by a third party organization. And, so, through high formalization Pentagon ensured (a) timely achievement of its R&D objectives, (b) adherence to its quality standards, and (c) protection of its intellectual property.

The cross-case analysis reveals that communication was another mechanism extensively used by firms to coordinate offshore R&D engagements. In all the offshore R&D engagements studied, frequent and extensive use of formal and informal communications was readily evident. Formal communication was used for project status updates and senior management reporting, and included reports, memos, and project documents. Informal communication was used for exchange of technical information. Parties in all the offshore R&D engagements heavily used telephone, electronic communications technology, and Internet infrastructure for frequent formal and informal communications. Extensive use of communication for coordination and integration across the offshore R&D engagements is not surprising, and is consistent with the received wisdom that flow of communication among R&D units improves R&D performance (Allen, 1977; Ghoshal and Bartlett, 1988; Nobel and Birkinshaw, 1998; Gupta and Govindarajan, 2000; Kim, *et. al.*, 2003). Because of the distributed and interdependent nature of task environments in offshoring of R&D, the flow of communication between two locations ensured alignment on objectives, tasks and approach, and facilitated exchange of vital information that improved R&D task performance (Burns and Stalker, 1961; Gupta and Govindarajan, 1991, 2000; Nobel and Birkinshaw, 1998). Interestingly, the cross-case analysis did not find support for the conjecture that distance compromises communication quality and frequency (Allen, 1977; Buckley and Carter, 2004). On the contrary, the findings indicate that in offshoring of R&D distance induced an increase in the frequency and density of communications. This is attributable to the need for headquarters to continuously monitor their offshore R&D units and availability of advanced communication technologies.

Finally, the cross-case analysis reveals that the firms used moderate level of socialization to coordinate and integrate intra-firm offshoring of R&D, and significantly low level of socialization to coordinate and integrate inter-firm offshoring of R&D. Frequent exchange of visitors between firm headquarters and offshore R&D units and cross-location task forces and committees stood out to be the two main socialization mechanisms in the offshore R&D engagements studied. Socialization at VERITAS and SAP also included use of job rotation programs. However, moderate/low level of socialization in offshore R&D engagements examined is somewhat surprising given its established primacy in management of global R&D (Martinez and Jarillo, 1989; Ghoshal and Bartlett, 1988, Gupta and Govindarajan, 2000). One reason for the moderate, and not high, level of socialization in intra-firm offshore R&D engagements is that most of the above mentioned socialization efforts require travel and cost money. Given the efficiency-seeking motive in offshoring of R&D, investments in socialization may offset the benefits from structural cost savings (Bartlett and Ghoshal, 2002). Another reason may have to do with the differences in culture between firm headquarters and offshore R&D units. Because socialization is based on shared norms, values and behaviors, it may not be effective when cultural differences are pronounced (Reger, 1999). On the other hand, the low level of socialization in inter-firm offshore R&D engagements can be attributed mainly to the temporary nature of relationships involving two different companies.

The case study findings also indicate that the use of socialization in offshoring of R&D had some association with the tenure of the engagement. The findings suggest that as the tenure of the engagement increased, the degree of socialization also increased. Likewise, the tenure of the people on the offshore R&D engagement also had an influence on the extent of socialization. In most of the offshore R&D engagements studied, managers at the firm headquarters expressed unhappiness with high mobility and turnover of the staff at the offshore R&D units. Therefore, it appears that the mobility and turnover of R&D resources at the offshore R&D units can also be a reason for the moderate to low, as opposed to high, degree of socialization in offshore R&D engagements. This reasoning finds support in studies that have shown that mobility and turnover of people affected socialization in global R&D networks (Baliga and Jaeger, 1984; Nohria and Ghoshal, 1997).

7.2.2 Relational Characteristics

Table 7.3 captures the key findings related to the relational characteristics of the offshore R&D engagements. All the offshore R&D engagements showed effective working relationships with varying degrees of trust and credibility. The findings suggest that trust and credibility co-evolved with the progression of offshore R&D engagements. However, all offshore engagements displayed some signs of tension. The cross-case findings suggest that tension between headquarters and offshore R&D units

Table 7.3: Relational Characteristics of Offshore R&D Engagements

Case	Overall Impression	Trust & Credibility	Distance	Procedural Justice
VERITAS	Established relationship with signs of strain due to increasing offshoring of R&D activities to India	Contributions and technical capabilities of the offshore R&D unit well established, although U.S. managers point to gap between aspiration and readiness at the offshore R&D unit	Principal and agent separated by ~13580 kilometers and 12½ hours; language at both locations is English; managers in the U.S. consider distance to be a problem for coordination but also an advantage in terms of cycle time (speed); distance affects ‘representation’ of the offshore R&D unit	Low; usually decisions are taken by the headquarters and communicated to the offshore R&D unit; strategy making is done by the respective product units at the headquarters; a sense of inequality prevails at the offshore R&D unit
SAP	Good working relationship, although fear of job loss among people in Germany and other locations due to unrestricted growth of R&D staff in India	Managers in Germany recognize the value of contributions made by the offshore R&D unit; mutual trust and appreciation exist	Principal and agent separated by 7408 kilometers and 3½ hours; although the official business language is English, people in Germany often use German for communication. Staff in India sometimes receives emails that include communication trails written in German	Low; all strategy and decision-making takes place at the headquarters; sometimes people from the offshore R&D unit participate in strategy discussions but do not have any influence on the process

Table 7.3: Relational Characteristics of Offshore R&D Engagements (…Continued)

Case	Overall Impression	Trust & Credibility	Distance	Procedural Justice
UHS	Effective working relationship between UHS headquarters and the offshore R&D unit	Mutual trust and respect exists; the relationship still evolving; the offshore R&D unit has to ‘sell’ its capability to obtain R&D work from the headquarters	Principal and agent separated by > 7000 kilometers and 3½ hours; cultural (language) difference exists between the headquarters and offshore R&D location	Low; all strategy and decision-making takes place at the headquarters; the offshore R&D unit is a recipient of the decision
Cordys	Good working relationship between Cordys headquarters and the offshore R&D unit in India	Mutual trust, appreciation, respect, openness, and collaboration; offshore R&D unit’s contributions and dedication well acknowledged by the headquarters	Principal and agent separated by 7715 kilometers and 3½ hours; Dutch language used for communication among people at Cordys headquarters, whereas English is used at the R&D unit in India	High; even though strategy- and decision-making happens at the headquarters, the offshore R&D unit is involved and understands the rationale behind decisions
Globetronix	Established working relationship bearing signs of tension due to increased outsourcing and offshoring; utilization of offshore R&D staff by business groups mandated by the headquarters	Mutual acceptance, although managers at the headquarters don’t seem to be satisfied with the performance of the offshore R&D unit	Principal and agent separated by > 7500 kilometers and 3½ hours; cultural (language) difference exists between the headquarters and offshore R&D location	Low; all strategy and decision-making is done by the headquarters; the offshore R&D unit is a recipient of the decision

Table 7.3: Relational Characteristics of Offshore R&D Engagements (…Continued)

Case	Overall Impression	Trust & Credibility	Distance	Procedural Justice
Frontier	Matured relationship; Pervasive also hosts a technology center for one of Frontier’s flagship products. The relationship is not exclusive, however. Also, the business models of the two companies are in conflict.	Good degree of trust, commitment and mutual respect; Pervasive has helped Frontier win quite a few customer contracts	Principal and agent separated by ~ 14000 kilometers and 10½ hours; English is used for communication at the headquarters as well as offshore R&D unit	Low; since Pervasive is one among many offshore R&D outsourcing partners of Frontier, the relationship is not exclusive. Frontier induces competition among its partners but expects Pervasive to demonstrate strong commitment towards its needs and interests.
Pentagon	Established relationship showing signs of deterioration due to conflicts in business interests as well as threat of potential job loss at the headquarters	Level of trust declined over the period of the engagement; also, the scope of responsibilities allocated to the offshore R&D unit decreased over time	Principal and agent separated by ~ 13000 kilometers and 9½ hours; English is used for communication at the headquarters as well as offshore R&D unit	Low; lack of a cohesive offshoring strategy allows individual managers to deal with the offshore R&D unit differently, leading to inconsistent decisions that affect the agent
ISS	Smoothly functioning outsourcing relationship	Mutual trust, appreciation, respect and transparency	Principal and agent separated by ~ 13000 kilometers and 9½ hours; English language used for communication at both the sites	Medium; the principal treats the offshore R&D unit in an inclusive manner and there is clarity on why decisions are taken in a certain way that affect the agent

existed owing to increasing movement of jobs to offshore R&D units, implying potential threat of jobs for people at headquarters. Also, the evidence suggests that the relationship between headquarters and offshore R&D unit was not peer-to-peer, and as such a sense of inequality prevailed at all the offshore R&D units. In addition, there existed a gap between the aspirations of the offshore R&D units to take on higher level responsibilities and achieve parity with headquarters R&D organizations, and headquarters' assessment of the capabilities of offshore R&D units.

In inter-firm offshore R&D engagements, an additional dimension added to the tension—conflict between the business interests of firms that constituted the exchange relationship, as indicated by the cases of Frontier and Pentagon. Frontier, for example, did not have an exclusive relationship with its offshore R&D outsourcing partner, Pervasive Technologies. In fact, Frontier had a network of relationships with many other firms like Pervasive, and did not commit any assured business to Pervasive. Both Frontier and Pentagon engaged their respective offshore R&D outsourcing partners opportunistically without providing any visibility on how the relationship could also drive the growth of their partners' businesses. And, yet, both Frontier and Pentagon insisted that their offshore R&D outsourcing partners made available the same set of R&D engineers for their future projects, whenever that might be. According to managers at Frontier and Pentagon, if the offshore R&D outsourcing partners did not make the same set of people available for their next projects, they would need to invest in learning curves of the new set of engineers, which, in turn, would impact R&D productivity and compromise the cost benefits of offshoring. On the other hand, for the offshore R&D outsourcing partners like Pervasive and Excel, who made their R&D resources available on time-and-material basis, earmarking R&D staff for any particular client without sustainable revenue would amount to compromising their business interests. Findings suggest that Pervasive and Excel routinely redeployed R&D resources who had gained experience on one client project to another client project in the same industry to establish credibility with the new client. According to managers at Pervasive and Excel, such rotation was also necessary to support career progression of their R&D resources.

The case study findings suggest that distance did not impact the relationship between firm headquarters and offshore R&D units in any significant way, although it did affect the ability of offshore R&D units to 'represent' themselves. Except for Cordys and ISS, the level of perceived procedural justice across all the offshore R&D engagements was low. In most of the cases, strategy and decision-making pertaining to offshoring of R&D was done by headquarters and decisions were simply communicated to the offshore R&D units. As such, in most of the cases the inclusion of offshore R&D units into the overall strategy and decision-making processes was low, even if the decisions taken affected the offshore R&D units. The principal-agent relationship structure and high degree of centralization appear to be the reasons for the low procedural justice. In contrast, the cases of Cordys and ISS showed higher procedural justice for their respective offshore R&D units. In the case of Cordys, the reason for high procedural justice can be attributed to the fact that nearly 70% of its R&D resources were located at its offshore R&D unit in India, where almost all the development took place. So, if R&D managers in India are not included in decision-making processes related to product development, Cordys runs the risk of goal misalignment and non-performance. On the other hand, in the case of ISS, procedural justice seemed to prevail because of the deliberate efforts made by ISS managers to improve the inclusivity of the offshore R&D unit with a view to improve R&D performance.

7.2.3 R&D Task Allocation to Offshore R&D Units

Table 7.4 captures the pattern of task allocation to the offshore R&D units across the cases studied. The cross-case analysis reveals that the criteria and practices for task allocation differed between intra-firm offshoring of R&D and inter-firm offshoring of R&D. However, within a given mode of offshoring of R&D (that is, intra-firm or inter-firm), task allocation criteria and practices showed similarities. For example, in the cases of intra-firm offshoring of R&D, the findings reveal that headquarters allocated (a) only those R&D activities to the offshore R&D units that did not require interface with customers and markets, (b) R&D tasks in such a way that interdependencies between headquarters and the offshore R&D were minimized, and (c) tasks based on the expertise available at the offshore R&D units. Moreover, the findings suggest that R&D tasks that required specialized domain knowledge (e.g., industry/profession specific knowledge) were generally not allocated to the offshore R&D units. In addition, the findings indicate that headquarters perception of offshore R&D unit's capabilities as well as risks associated with offshoring influenced task allocation decisions.

In the cases of inter-firm offshoring of R&D, allocation of tasks appeared to be primarily based on (a) degree of headquarters familiarity with the R&D tasks, (b) whether the task was repetitive in nature, and (c) the extent to which the task could be performed independently by an offshore R&D outsourcing partner. Findings suggest that when the degree of headquarters familiarity with specific R&D tasks was high, and if the headquarters had already performed similar R&D tasks before, offshore R&D outsourcing was preferred because such repetitive tasks did not involve any new knowledge. In addition, in the cases of Frontier and ISS, the specific expertise and complementary capabilities of their respective offshore R&D outsourcing partners influenced task allocation decisions. In both intra-firm and inter-firm offshore R&D engagements, the emphasis on minimizing interdependencies between headquarters and offshore R&D units in task allocation decisions stemmed from the need to achieve improved coordination efficiency and lower coordination costs.

Table 7.4: R&D Task Allocation Across Offshore R&D Engagements

Case	Approach for R&D Task Allocation to Offshore R&D Unit	Nature of R&D Tasks Allocated
VERITAS (Intra-firm)	• Allocate work that does not require customer or market interactions • Minimize interdependencies between locations • Assign ownership of mature products • R&D tasks assigned based on component/platform/feature ownership	Development of components for new products and enhancement of established products; creation of product variants; incorporation of new technologies into existing products
SAP (Intra-firm)	• Allocate work that does not require domain knowledge and interface with customers • Minimize interdependencies between locations • R&D tasks assigned based on technology areas or product layers (client/server)	Enhancement and maintenance of established products; creation of product variants on different form factors; incorporation of new technologies into existing products; migration to new technology platforms
UHS (Intra-firm)	• Assign software technology R&D tasks for medical system products/packages that don't require domain knowledge • Allocate work that does not require interface with customers • Minimize interdependencies between locations	Development of software product platforms for medical systems; system software development for medical electronics products; software development for clinical diagnostic packages; incorporation of new software technologies into medical system products
Cordys (Intra-firm)	• Assign all 'Development' activities • No interface with market or customers	Development of new software products and components

Table 7.4: R&D Task Allocation (…Continued)

Case	Approach for R&D Task Allocation to Offshore R&D Unit	Nature of R&D Tasks Allocated
Globetronix (Intra-firm)	• Assign software technology R&D tasks for consumer electronics products • Allocate work that does not require interface with customers • Minimize interdependencies between locations • R&D task assignment based on layers of software stack	Development of software product platforms for consumer electronics products; application and user interface software development for consumer electronics products; incorporation of new software technologies into consumer electronics products
Frontier (Inter-firm)	• Outsource resource-intensive, repeatable software R&D tasks for addressing diverse customer requirements	Software application development for digital signal processor platforms; software development for systems-on-chip
Pentagon (Inter-firm)	• Outsource software R&D tasks that don't require domain knowledge • Assign software component development tasks with well-defined specifications	Development and enhancement of components for digital media products; sustenance of digital media products
ISS (Inter-firm)	• Outsource software technology R&D tasks that don't require domain knowledge • Project based engagement with expected output specified	Development of software platform for integrated digital security solutions

The cross-case analysis indicated that no offshore R&D unit was assigned full responsibility for any particular product or product line. Instead, all the offshore R&D units were assigned only a subset of activities within the overall R&D value chain. The findings show that in the cases of intra-firm offshoring of R&D, the firms studied used three different approaches to task allocation for offshore R&D units: (a) component-based allocation, (b) platform-based allocation, and (c) feature-based allocation. In the component-based approach to R&D task allocation, headquarters assigned ownership for development of specific components of the product architecture to the offshore R&D units. In the platform-based approach to R&D task allocation, headquarters assigned responsibility for creation of a particular product on a new/different computing platform (e.g., Windows, Linux, or UNIX) or using a new technology (e.g., mobile devices). Finally, in the feature-based approach, headquarters assigned responsibilities for development of specific product features to the offshore R&D units. Case studies indicated that the feature-based approach created considerable sequential and reciprocal interdependencies between headquarters and the offshore R&D units and, therefore, increased coordination costs.

In contrast, R&D task allocation in the cases of inter-firm offshore R&D outsourcing was primarily based on assignment of specific and well-defined projects to the offshore R&D units. The scope of projects varied across cases from development of components and features (Pentagon) to creation of a new product platform (ISS) to development of applications and creation of product variants (Frontier). Interestingly, in almost all the cases, a considerable portion of the tasks allocated to the offshore R&D units involved R&D activities for established and mature products. Amongst the cases studied, Cordys was the only exception, where all Development activities were allocated to the offshore R&D unit and Research tasks were performed primarily at the headquarters.

Figure 7.1 shows the types of activities, mapped to different stages of product R&D, allocated by the case study firms to their offshore R&D units. The findings suggest that the quantum of early stage product R&D activities (research, concept development and validation, etc.) being performed offshore was very low. As the figure depicts, most of the offshore R&D activities related to product design and development, product enhancement and improvement, and product renewal. This clearly suggests that the firms leveraged offshoring of R&D to reduce cost of product development, accelerate revenues and improve margins by (a) adding more new features and (b) creating product variants at low costs, and (c) renew existing products to reduce the total cost of ownership for their clients.

Early Stage Product R&D Activities	Product Design & Development	Incremental R&D for Product Improvement	Late Stage Product R&D Activities
No new product conceptualization *Occasional technology R&D for new products*	*Design & Development of Features and Components for New Products*	*New Feature Development for Existing Products* *Product Performance Optimization and Product Stabilization* *Creation of Product Variants*	*Reinvent Products and Reduce Total Cost of Ownership* *Product Enhancements* *Incorporation of New Technology*
Very Low	High	Very High	Very High

Figure 7.1 Spectrum of R&D Activities at Offshore R&D Units

7.3 OFFSHORING OF R&D AND FIRM'S INNOVATIVE CAPABILITY

This section presents the cross-case findings on the link between offshoring of R&D and the studied firms' innovative capabilities. As explained in Chapter 4, there are dual paths to innovative capability in offshoring of R&D: (1) creation of innovative outputs by an offshore R&D unit and (b) transfer of knowledge from the offshore R&D unit to firm headquarters. Creation of innovative outputs by an offshore R&D unit depends on the structural characteristics of the offshore R&D engagement. On the other hand, knowledge transfer from the offshore R&D unit to firm headquarters depends on the characteristics of knowledge, efficacy of knowledge transfer mechanism deployed, and the motivational dispositions of the two parties involved in the exchange relationship. Section 7.3.1 presents and discusses findings related to the structural characteristics – innovative capability path, whereas the findings related to the knowledge transfer path are addressed in Section 7.3.2. Table 7.5 captures the cross case findings on innovation generation by the offshore R&D units and the organizational attributes associated with the innovations. The cross-case findings related to knowledge transfer from the offshore R&D units to firm headquarters are displayed in Table 7.6.

7.3.1 Innovation Generation by Offshore R&D Unit

Table 7.5 displays the cross-case findings on innovation generation by the offshore R&D units. For each offshore R&D engagement studied, the table captures the type(s) of innovative outputs, and the structural characteristics and organizational attributes associated with the innovative outputs. The findings indicate that incremental product

Table 7.5: Innovation Generation by Offshore R&D Units

Case	Type of Innovative Outputs	Structural Characteristics	Attributes Influencing Innovative Outputs
VERITAS (Intra-firm)	Some radical (Cluster File System, Dynamic Multipathing Technology) and many incremental (e.g., Allocator and FMR for Volume Manager) product/technological innovations; high per capita patent filings; innovation speed	High Centralization and Communication, and Moderate Formalization and Socialization	'Challenge'; initiative; desire to prove and achieve parity with U.S. R&D organizations; local autonomy; slack resources; young minds, fresh ideas without any heritage and inertia
SAP (Intra-firm)	Few incremental product innovations (Mobile Sales Solution, Allocator Run for AFS); few patents; innovation speed (more functionality in a given product release)	High Centralization and Communication, Low Formalization, and Moderate Socialization	Customer requirements; 'fresh' and energetic minds
UHS (Intra-firm)	Few incremental product (Field Service Framework for MIP, MR System/IS Package) and process innovations; product performance improvements; innovation speed (more features per release)	High Centralization and Communication, and Moderate Formalization and Socialization	Initiative to implement existing ideas; need to establish credibility; synergy across co-located product groups
Cordys (Intra-firm)	Many incremental product (Orchestrator, Portal) and process (SCRUM) innovations	Participative Centralization, High Communication, Low Formalization, and Moderate Socialization	Autonomy; initiative; recognition

Table 7.5: Innovation Generation by Offshore R&D Units (…Continued)

Case	Type of Innovative Outputs	Structural Characteristics	Attributes Influencing Innovative Outputs
Globetronix (Intra-firm)	Few incremental product innovations (DVD Software, Media Server); innovation speed (through reuse)	High Centralization and Communication, and Moderate Formalization and Socialization	Initiative to implement existing ideas; cross-fertilization of ideas across product lines
Frontier (Inter-firm)	Few incremental product innovations (product design); innovation speed and variety; complementary innovation (Multimedia Solutions for Frontier's DSP Platforms)	High Centralization and Communication, and Moderate Formalization and Low Socialization	The agent's desire to establish credibility with the principal and grow the relationship through demonstrated performance; a few capable and motivated engineers for whom innovation was a way to express their expertise
Pentagon (Inter-firm)	One radical product innovation (Broadcast Server) and few incremental product innovations (Codecs); innovation speed through extended engineering work hours	High Centralization, Formalization and Communication, and Moderate Socialization	Fresh mind and no 'heritage' effect; the agent's motivation to prove and establish credibility with the principal; challenge; initiative; and technical constraints
ISS (Inter-firm)	One radical product innovation (Integrated Digital Security Solution Platform)	High Centralization and Communication, and Moderate Formalization and Low Socialization	Fresh perspectives not locked in any paradigm; initiative; the agent's motivation to establish deeper relationship with the principal through demonstrated performance; constraint

innovations were the predominant type of innovative outputs produced by the offshore R&D units studied, although the cases of VERITAS, Pentagon, and ISS also reveal instances of radical product innovations. The cross-case analysis also indicates that higher innovation speed was an outcome of offshoring of R&D. In addition, the case studies reveal several instances of incremental process innovations contributed by the offshore R&D units. However, most of the process innovations were introduced primarily either to cope with the challenges associated with globally distributed R&D or to automate the software testing processes. As such, except in the case of Cordys, the process innovations introduced by the offshore R&D units did not have any measurable impact on firm's innovative capability, including innovation speed.

The cross-case analysis reveals five common attributes that influenced the ability of the offshore R&D units to generate incremental and radical product innovations: (1) degree of autonomy of the offshore R&D units in R&D task performance, (2) the ability of headquarters to 'challenge' offshore R&D teams with daunting R&D goals, (3) the ability of offshore R&D teams to take initiatives in response to challenges and opportunities, (4) absence of 'heritage' effects at offshore R&D units, and (5) the desire of offshore R&D team members to establish their credibility and achieve parity with headquarters R&D teams. The findings suggest that whenever managers at headquarters challenged offshore R&D teams with highly innovative tasks and stretch performance targets, and gave them the autonomy to pursue their own technical directions, offshore R&D units produced significant innovative outputs. The 'challenge' induced offshore R&D teams to take initiatives to achieve the best solutions to innovation goals. Also, due to relatively young age of the offshore R&D units, they did not have an administrative heritage and thus were not locked into any particular path-dependent technological trajectory or paradigm. On the other hand, R&D teams at firm headquarters showed rigidity and inertia because of their familiarity and prior experiences with certain technological paradigms. In addition, the findings indicate that a high intensity of desire among offshore R&D team members to achieve parity with headquarters R&D teams stimulated their innovative performance.

For example, according to the Vice President of VERITAS Foundation Products, the competitive need for Cluster File System (CFS) had existed for some time, but the concerned R&D group at headquarters was non-believer of the technology and, therefore, strongly resisted its development. So, the Vice President called upon a team at VERITAS' India R&D center to work on CFS. The team in India successfully demonstrated a prototype and subsequently developed the full product, which went on to become a significant revenue earner for VERITAS. The R&D group at the headquarters showed inertia and rigidity because of their path-dependent learning and belief system, whereas the team in India found CFS R&D as an opportunity to perform cutting edge, technically complex work as well as to demonstrate their capability to headquarters. Similarly, the VERITAS India R&D team developed the path-breaking DMP technology for Volume Manager in just 3 months as opposed to an estimated 1 year by the concerned R&D group in the U.S. Again, an analysis of the VERITAS case indicated that the motivation to respond to a daunting challenge and 'prove' themselves was at center of India R&D team's success with DMP technology development project. The case study findings reveal that the VERITAS India R&D teams that developed CFS and DMP were provided autonomy and management support throughout the duration of the two projects.

Similarly, faced with critical technical constraints, when Excel (agent's) engineers re-conceptualized Pentagon's Video Broadcast Server and developed a new product at $1/10^{th}$ of the original cost, Pentagon's sales zoomed with the new market-leading product. The new product, based on the PC platform, was not only low cost but also modular, and more importantly, did not have any dependencies on third-party hardware vendors unlike its previous version. What brought about such a major innovation by Excel R&D engineers? An analysis of Pentagon's offshore R&D outsourcing engagement with Excel reveals three factors that catalyzed the innovative outcome: the felt challenge by Excel's R&D lead to deliver path-breaking results and establish Excel's credibility with its client (Pentagon), initiative by Excel's R&D lead, and fresh technical ideas and perspectives that Pentagon's engineers locked in a particular technological trajectory failed to visualize. Similarly, the development of a highly innovative integrated digital security solution platform by Leading Technologies Labs (LTL) for ISS can be attributed to (a) the ability of LTL R&D engineers to deploy fresh technical perspectives not locked in any particular technological paradigm and (b) initiative by LTL R&D engineers. The stimulations for LTL's initiative itself came from the challenge to develop an innovative product while addressing the constraints imposed by ISS as well as the need to establish credibility with ISS managers through demonstrated technical capabilities.

The findings related to attributes that influenced generation of innovation by offshore R&D units find support in the extant literature. For example, in both innovation management and R&D globalization literature, higher degree of autonomy is regarded to be positively associated with an organization's innovative capability (e.g., Damanpour, 1991; Jansen, *et. al.*, 2006; Ghoshal and Bartlett, 1988; Persaud, *et. al.*, 2002). Also, organizational scholars have shown that the administrative heritage (or age) of an organization inhibits its innovative capability because of established and mature organizational routines, which cause structural inertia and rigidity (Leonard, 1995; Ahuja and Lampert, 2001). In addition, Leonard (1995) has argued that different units in an organization exhibit different cognitive styles due to their path dependence and cultural orientation. Thus, firms can leverage the diversity in cognitive styles of their various organizational units to enhance their innovative capability. In the specific domain of multinational management, Birkinshaw and his associates (Birkinshaw, 1997; Birkinshaw, *et. al.,* 1998) have shown that the ability of subsidiaries to take meaningful initiatives is positively associated with their parent firm's innovation performance. Mudambi, *et. al.* (2007) have shown that the motivation levels of team members at globally dispersed R&D subsidiaries are directly correlated with their innovative performance.

The cross-case findings indicate that all the product innovations generated by offshore R&D units were based on ideas or needs that had already existed but not acted upon by firm headquarters either because of other priorities or structural rigidity. The offshore R&D units took the initiatives to develop the existing ideas and translated them into innovative outcomes. High degree of communication between the offshore R&D units and firm headquarters facilitated offshore R&D units' access to existing ideas and needs. Likewise, the offshore R&D unit's understanding of customer requirements that catalyzed innovative outcomes was also facilitated by high degree of communication between firm headquarters and offshore R&D units. The findings reveal that in the cases of intra-firm offshoring of R&D, socialization between offshore R&D units and firm headquarters, enabled through frequent visits and cross-location committees, influenced the generation of innovative outputs by the offshore R&D units. In fact, across the cases studied, confluence of communication and socialization promoted exchange of information and experiences between offshore R&D units and firm headquarters, which, in turn, guided the innovation efforts of the offshore R&D units. These findings are consistent with studies on globalization of R&D that suggest that higher levels of communication and socialization are positively associated with the innovative capability of globally distributed R&D units (Gupta and Govindarajan, 2000; Nohria and Ghoshal, 1997; Ghoshal and Bartlett, 1988; Persaud, 2005).

In the cases of VERITAS, UHS, and Globetronix, many product R&D groups were located 'under one roof' at their offshore R&D units and, therefore, internal communication and socialization among them facilitated exploitation of cross-group synergies, leading to innovative outcomes. Development of the MIP platform by UHS's offshore R&D unit in India represents a good example of exploitation of cross-group synergies for innovation. Different medical diagnostic systems like X-Ray, MR, and Ultrasound produced by UHS share a common set of functionalities like image capturing, image storing, image transmission, and image presentation. Earlier, however, each system had its own implementation of these functionalities for which the respective product R&D groups at UHS's offshore R&D unit were responsible. However, UHS offshore R&D unit, with support from headquarters, took the initiative to develop a common MIP platform that would be used across all diagnostic products. The development of the common MIP platform was based on systematic leverage of cross-group synergies and led to an innovation that was not only cost effective but also accelerated speed of product development across various medical systems product line. High levels of inter-group communication and socialization were at the core of cross-group synergy exploitation within UHS's offshore R&D unit. The positive influence of cross-group synergy within the offshore R&D units on their ability to generate innovations finds support in the literature (see, for example, Leonard, 1995; Nonaka and Takeuchi, 1995).

The cross-case analysis shows that in all the cases studied firm headquarters used moderate to low level of formalization to coordinate their offshore R&D activities. Formal plans, reviews and reporting mechanisms, and documented product development processes were used by headquarters to orchestrate the efforts of the offshore R&D units, and align and integrate them with the overall innovation efforts at the firm level. Formal plans were used to define project goals and schedules as well as to define responsibilities of the offshore R&D units, whereas formal reporting and reviews were used by firm headquarters to monitor progress of projects at the offshore R&D units. Product development processes, on the other hand, not only provided a common terminology for geographically and culturally distant teams, but also defined standards for deliverables and outputs for different phases of the development life cycle. The cross-case findings do not provide any evidence that formalization had any impeding effect on the ability of offshore R&D units to produce innovations. On the contrary, the case studies suggest that without formalization, the ability of firms to efficiently coordinate globally distributed R&D activities would have been greatly impacted. In particular, formalization was necessary for coordination of inter-dependent innovation tasks between headquarters and offshore R&D units. This finding contrasts with the received wisdom in both innovation literature and R&D globalization literature that generally regard formalization to have a negative correlation with an organization's innovative capability (Damanpour, 1991; Nohria and Ghoshal, 1997; Kim, *et. al.*, 2003).

As mentioned in the beginning of this section, the cross-case analysis indicates that offshoring of R&D was positively associated with innovation speed. How was higher innovation speed achieved through offshoring of R&D? The findings suggest that firms gained innovation speed by either (a) exploiting time zone differences between locations to achieve higher number of engineering hours per business day and thus accelerate product development schedules or (b) leveraging the additional R&D capacity available through offshoring of R&D to bundle more features in a given product release. The cases suggest that an optimal degree of centralization and formalization was necessary to achieve higher innovation speed. Without centralization, goal alignment and seamless integration of geographically distant offshore R&D units into the overall innovation efforts was not possible, whereas without formalization, addressing interdependencies and the need for synchronization between offshore R&D units and firm headquarters was difficult. On the other hand, excessive centralization and formalization were found to hamper the innovative scope and creative abilities of the offshore R&D units. These findings are consistent with studies on innovation speed that suggest that goal clarity, better project integration, team autonomy, and use of efficient product development processes positively influence innovation speed (De Meyer and Mizushima, 1989; Kessler and Chakrabarti, 1996; Eisenhardt and Tabrizi, 1995; Ettlie, 1995).

However, the cross-case findings highlight that generally the ratio of innovation volume to number of R&D resources across offshore R&D units was low. There can be four possible reasons for this: (1) lack of autonomy of offshore R&D units, (2) restricted innovative scope of the R&D tasks allocated to the offshore R&D units, (3) insufficient capability of the offshore R&D units for innovation generation, and (4) distance of the offshore R&D units from customers and markets. Given that almost all the offshore R&D units examined produced some innovative outputs, the issue of low innovation volume cannot be simply attributed to their capabilities. Distance from customers and market(s) is definitely one reason for the low innovation volume because it affected the ability of the offshore R&D units to interact with customers to understand their requirements and develop innovative products. Informants both at firm headquarters and offshore R&D units also readily confirmed this. However, the findings indicate that the effect of distance could be alleviated by allocating offshore R&D units innovative tasks that did not require proximity to customers and markets, such as generation of technological innovations crucial for product competitiveness.

High degree of centralization applied for governance of the offshore R&D units is another reason for the offshore R&D units' low innovation volume. In all the cases studied, firm headquarters determined the budget and resource levels for the offshore R&D units. Also, the scope and type of tasks allocated to the offshore R&D units were decided by firm headquarters. In addition, firm headquarters also decided the priorities and schedules for tasks to be performed at the offshore R&D units. Importantly, no offshore R&D unit examined had full responsibility for any single product or product line. Instead, all the offshore R&D units studied carried out parts of R&D activities for specific products, and outputs produced by them were simply integrated into the overall product R&D value chain by headquarters. Also, whilst headquarters managers' perception of offshore R&D units' capabilities influenced task allocation decisions, informant interviews across cases implied that the tendency to not part with 'innovative work' and the fear of job loss among headquarters managers also mediated the R&D task allocation decisions. As such, the examined offshore R&D units did not have any autonomy (except for recruitment and development of their staff) and tasks allocated to them generally did not offer much scope for generation of innovations.

Thus, the reason for the low innovation volume produced by the offshore R&D units can be primarily attributed to the high degree of centralization used by firm headquarters to govern them. This is consistent with findings in previous studies on globalization of R&D that have found centralization to be negatively correlated with the ability of global R&D units to create innovation (e.g., Ghoshal and Bartlett, 1988; Nohria and Ghoshal, 1997; Nobel and Birkinshaw, 1998; Persaud, *et. al.*, 2002). However, the cross-case analysis reveals another dimension linking offshoring of R&D and firm innovative capability. As discussed in Section 7.2.3 (see Figure 7.1), all the firms that this research examined leveraged offshoring of R&D for product design and development activities and incremental product innovation R&D activities. The findings reveal that by moving parts of product development and incremental R&D activities to offshore R&D units, headquarters freed-up their R&D capacity to pursue new/exploratory innovation activities. Thus, by offshoring their R&D activities, firms (a) expanded their overall R&D capacity, (b) leveraged offshore R&D units for incremental R&D activities, and (c) freed-up R&D capacity at headquarters to focus on exploratory R&D activities for development of new products and technologies.

The findings show that by offshoring R&D activities the case study firms were able to simultaneously pursue a wide variety of R&D activities at low cost. Thus, an enhanced R&D capacity achieved through offshoring was positively associated with the innovative capability of the firms studied. This is consistent with empirical studies on innovation that have found the size of an organization to be positively correlated with the organization's innovative capability (Damanpour, 1991). In addition, the findings suggest that when the firms leveraged offshore R&D engagements for incremental R&D activities and deployed their more experienced R&D engineers for pursuing exploratory innovation activities, their overall innovative capability improved. In essence, through offshoring of R&D, the case study firms developed the capability to simultaneously pursue exploitative (incremental) and exploratory R&D activities. This finding is noteworthy because the ability to simultaneously pursue a portfolio of exploitative and exploratory innovations—often referred to as ambidexterity— is an important determinant of the competitiveness of high technology firms (March, 1991; Tushman and O'Reilly, 1996).

Finally, the cross-case analysis shows that many of the firms studied maintained some slack resources at their offshore R&D units and leveraged these resources for carrying out experimental R&D activities in new technology areas. The findings suggest that the case study firms could afford to maintain slack because of the low cost of resources at offshore R&D units. Interestingly, in the cases of inter-firm offshoring of R&D, the relationship of the case study firms with their R&D outsourcing partners itself served as a source for slack resources. The case study firms approached their offshore R&D outsourcing partners as and when additional R&D capacity or complementary technical capabilities were needed. Thus, the case study firms gained access to slack resources on-demand without investing in accumulation and maintenance of slack resources. Taken together, the case study firms utilized the slack resources available at the offshore R&D units for carrying out experimental R&D activities, evaluating new technologies, and for creation of innovation variants. These findings are consistent with studies on organizational innovation that view availability of slack resources to be positively associated with the firm's innovative capability (Damanpour, 1991; Cyert and March, 1992; Nohria and Gulati, 1996).

7.3.2 Knowledge Transfer from Offshore R&D Unit to Firm Headquarters

Table 7.6 displays the cross-case findings on transfer of knowledge from the offshore R&D units to firm headquarters. The findings show that the firms studied employed a variety of mechanisms to facilitate the transfer of knowledge from offshore R&D units. These included transfer of knowledge through codification—documentation of product architecture and design, new feature proposals, and invention disclosures, and formal and informal communications, cross-location task forces and committees, and social interactions among geographically dispersed organizational members. All the offshore R&D engagements made extensive use of modern electronic infrastructure for exchange of knowledge. However, surprisingly, the findings suggest that, except in some specific situations, transfer of knowledge from the offshore R&D units to firm headquarters was not an explicit objective in any of the offshore R&D engagements studied. Moreover, even the informants at firm headquarters did not exhibit any motivation to engage in the process of knowledge transfer from the offshore R&D units.

The reason for the lack of explicit emphasis on, and motivation for, transfer of knowledge from the offshore R&D units to firm headquarters appears to be the low knowledge differential between offshore R&D units and firm headquarters. The findings indicate that in almost all the cases the bulk of R&D activities being performed at the offshore R&D units were originally performed at firm headquarters. As a result, the stock of knowledge developed at the offshore R&D units was largely duplicated. In other words, the stock of knowledge that resided at the offshore R&D units was already available at firm headquarters. Also, the absorptive capacity of the firm headquarters across cases was high because they had earlier performed the same R&D activities that were now being performed by offshore R&D units. Thus, the issue of knowledge transfer cannot be cast on the absorptive capacity of firms headquarters in the cases of the offshore R&D engagements studied.

Table 7.6: Knowledge Transfer from Offshore R&D Units to Firm Headquarters

Case	General Observations on Knowledge Transfer	Absorptive Capacity of the Principal	Knowledge Transfer Mechanisms	Motivational Dispositions of the Principal and Agent
VERITAS (Intra-firm)	Knowledge transfer not an explicit objective; however, co-location of product groups under 'one roof' at the offshore R&D unit facilitates exploitation of synergies through transfer of knowledge	High	Documentation, invention disclosures, feature proposals, social interactions, formal and informal communication and interactions, cross-location task forces and committees, and embedded in products	The agent's knowledge stock is largely duplicated; low knowledge differential affects the principal's motivation to engage in knowledge transfer from the agent; also NIH syndrome
SAP (Intra-firm)	Knowledge transfer from the agent to principal is not a goal	High	Documentation, embedded in products, social interactions, formal and informal communication, and electronic forums	The agent's stock of knowledge is similar to (duplicated) and yet not as rich as that of the principal; hence knowledge transfer is not an objective for the principal
Cordys (Intra-firm)	Knowledge transfer from the agent to principal is not a goal yet	High	Documentation, embedded in products, formal and informal communication, cross-location committees, and electronic forums	The agent's stock of knowledge is similar to (duplicated) and yet not as rich as that of the principal; hence knowledge transfer is not an objective for the principal

Table 7.6: Knowledge Transfer from Offshore R&D Units to Firm Headquarters (…Continued)

Case	General Observations on Knowledge Transfer	Absorptive Capacity of the Principal	Knowledge Transfer Mechanisms	Motivational Dispositions of the Principal and Agent
UHS (Intra-firm)	No emphasis on knowledge transfer from the agent to principal; however, location of many product R&D groups at the offshore R&D unit under one roof facilitates knowledge sharing and promotes exploitation of cross-group synergies	High	Documentation, feature proposals, social interactions, formal and informal communication, embedded in products, and electronic forums	The agent's knowledge stock is largely duplicated; low knowledge differential affects the principal's motivation to engage in knowledge transfer from the agent especially since the differential knowledge is not directly relevant for the principal
Globetronix (Intra-firm)	Knowledge transfer from the agent to principal not an objective but location of R&D groups under one roof at the offshore R&D unit facilitates cross-fertilization of knowledge and exploitation of cross-group synergies	High	Documentation, feature proposals, formal and informal communication, embedded in products, electronic forums, exchange of people, and cross-location architect's council	The agent's knowledge stock is largely duplicated; low knowledge differential affects the principal's motivation to engage in knowledge transfer from the agent especially since the differential knowledge is not directly relevant for the principal

Table 7.6: Knowledge Transfer from Offshore R&D Units to Firm Headquarters (…Continued)

Case	General Observations on Knowledge Transfer	Absorptive Capacity of the Principal	Knowledge Transfer Mechanisms	Motivational Dispositions of the Principal and Agent
Frontier (Inter-firm)	Knowledge transfer not an explicit goal; the principal's program manager serves as the integrator of knowledge	High	Comprehensive documentation, formal and informal communications, and embedded in products	The principal not motivated to transfer knowledge from the agent because of absence of knowledge differential
Pentagon (Inter-firm)	Formal knowledge transfer in some cases	High	Documentation, training, formal and informal communication, and embedded in products	Emphasis on formal transfer of knowledge whenever the agent possessed differential knowledge also highly relevant to the principal
ISS (Inter-firm)	Knowledge transfer a secondary goal	Medium	Documentation, design proposals, embedded in products, and formal and informal communication	The principal keen to learn from the agent's experiences on other client projects

Even though the duplicated stock of knowledge at the offshore R&D units got refined and enriched through cross-fertilization and pooling of ideas, the cross-case findings indicate that firm headquarters viewed the knowledge differential to be small. As a result, firm headquarters did not consider it necessary to systematically pursue knowledge transfer from the offshore R&D units. Even in some situations, when the stock of knowledge possessed by the offshore R&D units differed from that at firm headquarters, knowledge transfer did not appear to be an explicit objective. The reason for this, the findings suggest, was that the firm headquarters did not view such differential knowledge as relevant to them. The only exception was the case of Pentagon. When Excel, Pentagon's offshore R&D outsourcing partner, successfully developed the new Video Broadcast Server, Pentagon insisted on formal transfer of knowledge because the entire knowledge base for the product resided only with Excel. These findings on knowledge transfer are consistent with the received wisdom that suggests that the headquarters' propensity to absorb knowledge from a global R&D unit is influenced by whether a particular global R&D unit's stock of knowledge is relevant and relatively new to the headquarters (Hansen and Lovas, 2004; Song and Shin, 2008).

Although, the transfer of knowledge from offshore R&D units to firm headquarters did not appear to be an explicit goal, as discussed in the beginning of this section, mechanisms for knowledge transfer existed and were deployed by all the case study firms. Thus, the transfer of knowledge from an offshore R&D unit to firm headquarters was facilitated through codification (documents, reports, proposal, and invention disclosures), embodiment in innovative outputs (products and components), communications (meetings, emails, and Intranets), and social interactions. Given the moderate level of socialization in the cases of intra-firm offshoring of R&D, and high degree of communication across all the offshore R&D engagements studied, it is conceivable that some knowledge transfer took place through informal communications and social interactions among globally dispersed organizational members. However, in this study, it was not possible to capture the extent and nature of such knowledge transfer. The findings suggest a preference for codification because codified knowledge could be easily and speedily communicated and transferred (Szulanski, 1996; Kogut and Zander, 1993). The spatial and cultural distances between the offshore R&D units and firm headquarters did not appear to have any influence on the flow of knowledge in the cases studied. Nor did the findings highlight anything to suggest any motivational disposition issues at the offshore R&D units for knowledge transfer.

The findings, however, suggest a different dimension of knowledge transfer that was at work in some of the offshore R&D engagements. Take the cases of VERITAS, UHS, Cordys, and Globetronix. All of these are multi-product companies but their different product units were headquartered at different locations in the same country. As a result, R&D groups from different product units did not usually interact with each other and explore any potential synergies. On the other hand, the offshore R&D units of all the three companies in India housed multiple product groups under one roof, which permitted exchange of knowledge among different product groups. Such exchange of knowledge resulted in exploitation of synergies across groups, as evident from the case studies of the above four companies. For example, in VERITAS and UHS, user interface technologies developed for one particular product group was later used across multiple product groups, all located at offshore R&D units. Likewise, in the case of Globetronix, the knowledge gained by one product team in developing the Media Center was later exploited by another product team for the development of Media Server product. Since the R&D engineers associated with these two products were co-located at the offshore R&D unit, knowledge transfer took place through informal communications and socialization.

7.4 OFFSHORING OF R&D AND FIRM'S ORGANIZATIONAL FLEXIBILITY

A tabular display of cross-case findings related to offshoring of R&D and organizational flexibility is shown in Table 7.7. As the findings suggest, operational flexibility was a common theme across all the cases of offshore R&D engagements studied. Without exception, all the firms leveraged offshoring of R&D to ramp-up and ramp-down resources on their projects in accordance with their emergent needs. In the cases of intra-firm offshoring of R&D, the case study firms accumulated a large R&D capacity at their offshore R&D units, which they leveraged for achieving operational flexibility. Easy availability of well-qualified knowledge resources available at low costs permitted the firms to build such large R&D capacity. Thus, whenever there were fluctuations in the market, the firms quickly leveraged offshore R&D units to adjust the volume or mix of their products to address the emergent market demands.

Also, the offshore R&D units had a sizable number of resources with generic R&D skills, and largely possessed duplicated knowledge—that is, stock of knowledge similar to that at firm headquarters. As a result, the firms were able to produce a number of different products or product variants at the same time, or accelerate delivery of products due to the added R&D capacity but at considerably low costs. In the cases of inter-firm offshoring of R&D, the studied firms accessed the R&D capacity available with their offshore R&D outsourcing partners, who provided generic but diverse R&D skills needed for innovation. Naturally, inter-firm offshoring of R&D afforded greater operational flexibility because the firms did not have to incur any fixed costs in hiring and maintaining R&D resources. The findings suggest that in addition to the low cost and easy availability of R&D resources, relatively less stringent labor laws in India were the enablers of operational flexibility.

Table 7.7: Organizational Flexibility through Offshoring of R&D

Case	Operational Flexibility	Structural Flexibility	Strategic Flexibility
VERITAS (Intra-firm)	Ability to rapidly ramp-up/down resources to staff new R&D projects	Change in allocation of responsibilities between groups at the principal and agent locations	Creation of integrated solutions by leveraging cross-product/technological expertise; explore and exploit new technologies for product renewal and competitiveness
SAP (Intra-firm)	Ability to quickly ramp-up/down resources on R&D projects in accordance with need	Not evident	Not evident
UHS (Intra-firm)	Ability to quickly ramp-up/down resources on R&D projects in accordance with need	Not evident	Not evident
Cordys (Intra-firm)	Ability to quickly ramp-up/down resources on R&D projects in accordance with need	Not evident	Ability to explore/evaluate/incorporate emerging technologies through rapid prototyping at low costs
Globetronix (Intra-firm)	Ability to quickly ramp-up/down resources on R&D projects in accordance with need	Not evident	Not evident

Table 7.7 Organizational Flexibility through Offshoring of R&D (…Continued)

Case	Operational Flexibility	Structural Flexibility	Strategic Flexibility
Frontier (Inter-firm)	Ability to access R&D resources as and when required without incurring fixed costs	Ability to assemble temporary R&D teams to pursue emergent innovation requirements; sourcing of components from the offshore R&D outsourcing unit; co-design of solutions with the offshore R&D unit	Not evident
Pentagon (Inter-firm)	Ability to access R&D resources as and when required without incurring fixed costs	Not evident	Not evident
ISS (Inter-firm)	Ability to access R&D resources as and when required without incurring fixed costs	Not evident	Not evident

The findings are consistent with observations made by Suarez, *et. al.* (1991) and Volberda (1996) that additional R&D capacity endows operational flexibility. The findings also find support for the positive correlation between duplication of technical capabilities across globally distributed R&D units and operational flexibility (Zander and Sölvell, 2000).

The findings suggest that VERITAS and Frontier leveraged offshoring of R&D for structural flexibility as well. Both companies leveraged their offshore R&D units to achieve new structural configurations at low costs. Take the case of VERITAS, whose 900 people strong offshore R&D unit in India possessed a combination of duplicated and diverse knowledge capabilities. The VERITAS case study revealed that the firm frequently established and dismantled new R&D teams by leveraging resources at its offshore R&D unit to achieve congruence with market demands. Also, in VERITAS, major innovations such as Cluster File System and Dynamic Multipathing Technology were achieved by establishing R&D teams at the company's offshore R&D unit to overcome structural inertia and rigidity at headquarters R&D organizations. Essentially, VERITAS was able to establish a new R&D team structure to traverse a different learning trajectory required to cope with the demands of its competitive environment. The case of Frontier, on the other hand, shows that the company routinely leveraged its offshore R&D outsourcing partner to quickly assemble R&D teams to address emergent innovation requirements, source components and knowledge assets necessary for innovations, and co-design new products. These observations find support in theoretical discourses and empirical findings that highlight the role of structural forms for organizational flexibility (Nelson and Winter, 1982; Leonard, 1995; Volberda, 1996; Sanchez, 1995).

Finally, the cases of VERITAS and Cordys show that these two companies also leveraged offshoring of R&D for strategic organizational flexibility to some extent. Both these companies leveraged their offshore R&D units to develop a diversified R&D portfolio at low cost to enhance their repertoire of strategic flexibility options. For example, VERITAS pursued R&D for integrated data management solutions at its offshore R&D units in anticipation of new market trends and to create new market spaces for itself. VERITAS also maintained slack resources at its offshore R&D unit to carry out prototyping activities for new technologies and products. In addition, VERITAS' offshore R&D was entrusted with the responsibility for fundamental renewal of many of its products through incorporation of new technologies. A case in point was renewal of VERITAS NetBackup product by replacing tape based storage technology with disk based storage technology. Cordys, on the other hand, maintained some slack resources at its offshore R&D unit to carry out rapid prototyping at low costs, and to explore, evaluate, and incorporate emerging technologies critical for its product competitiveness. These observations find resonance with scholars who have highlighted the need to leverage different organizational forms to build options for strategic organizational flexibility (Buckley and Cason, 1998; Aaker and Mascarenhas, 1984; Bowman and Hurry, 1993; Evans, 1982; Hitt, *et. al.*, 1998; Sanchez, 1997; Volberda, 1996).

The cross-case analysis also surfaced an unanticipated but interesting dimension associated with offshoring of R&D. The case studies revealed two other types of flexibilities that may be termed as ‘cultural flexibility’ and ‘cognitive flexibility’. Many informants at firm headquarters said that people at the offshore R&D units exhibited considerable flexibility in adjusting their work hours, often worked long hours, and demonstrated a very strong commitment to their tasks. According to headquarters managers, people at the offshore R&D units showed flexibility in working across time zones, accepted stretch goals, willingly traveled at short notices, and worked beyond office hours and on weekends to achieve project goals. In addition, many informants at firm headquarters indicated that such flexibility also made alignment on goals and technical directions between the two locations easy and facilitated speed of execution. The findings across the cases studied suggested that managers at firm headquarters greatly valued such cultural flexibility. It is conceivable that such cultural flexibility was unique to the Indian context and could vary across other offshore R&D country locations. Another possible reason for the cultural flexibility demonstrated by the offshore R&D team members could be attributed to their need to grab every opportunity to establish technical credibility and inch towards achieving parity with headquarters R&D organizations. Whatever might be the reasons, it is intuitively understandable that cultural flexibility was positively associated with R&D performance.

Cognitive flexibility, on the other hand, concerned with the flexibility with which the offshore R&D team members accepted R&D assignments. Unlike people at firm headquarters, R&D engineers at the offshore R&D units generally did not show affinity or preference for any particular technology, and moved from one technology to another as the requirements emerged. Not only that, R&D staff at the offshore R&D units also demonstrated quick ability to learn and apply new technologies. On the other hand, people at firm headquarters often displayed resistance towards the use of new technology and preferred to stick to what they were familiar with, as exemplified by many of the cases studied. The resistance to new ideas and technologies by people at firm headquarters stemmed from their path dependence, which locked their perspectives in particular technological paradigms. The cognitive flexibility on the part of the people at offshore R&D units can be attributed to their relatively young age and less work experience when compared to their counterparts at firm headquarters. Also, given the accumulation of generic knowledge resources and inconsistent pattern of task allocation, the offshore R&D units had yet to establish any technological or learning trajectory of their own. Therefore, the offshore R&D units did not have the cognitive rigidity or inertia that headquarters R&D organizations demonstrated. The findings indicated that the cognitive flexibility of the people at offshore R&D units was instrumental in transfer of a variety of innovative tasks, to the offshore R&D units as also in freeing-up of the R&D capacity at firm headquarter.

Finally, of course, the cross-case findings clearly indicate that the ability of the studied firms to leverage offshoring of R&D for organizational flexibility depended not only on the flexibility of resources at the offshore R&D units but also on their capability to reconfigure and redeploy these resources. This observation is consistent with findings in empirical studies on organizational flexibility (Sanchez, 1995, 1997; Sanchez and Mahoney, 1996).

7.5 CONCLUSIONS

This chapter discerned and discussed the similarities and differences across the offshore R&D engagements studied. As the cross-case analysis suggested, all the 8 offshore R&D engagements examined in this research were established with the intertwining motive of gaining access to a large number of R&D resources at low cost. As the findings suggested, all the offshore R&D engagements evolved in their scope and volume of R&D activities since they were first established. However, this research did not find any offshore R&D unit that had complete R&D ownership for any product or product line, even though some of the offshore R&D units had existed for several years. Instead, the offshore R&D units examined carried out parts of R&D activities for the overall R&D value chain of their respective parent firms (Principals). Noticeably, the findings indicated that usually the studied firms allocated to their offshore R&D units well-defined R&D tasks that involved (a) development of product components and features,(b) creation of product variants, and (c) incremental R&D activities for product improvement, enhancement, and renewal. Thus, the innovative activities assigned to offshore R&D units were bound not only in scope but also time. Accordingly, by and large, the offshore R&D units produced incremental innovative outputs. Further, the findings suggested that generally the innovation to R&D resources ratio across the offshore R&D units was low.

The cross-case analysis revealed that the studied firms employed strong centralization and high degree of communication to coordinate their offshore R&D engagements. The analysis suggested that the low innovation to resources ratio at the offshore R&D units was attributable primarily to high degree of centralization employed to govern them. As such, the offshore R&D units did not have the latitude to define and pursue their own R&D agenda. However, given the distributed and participative nature of offshore R&D activities, both centralization and formalization are inevitable for governance of offshore R&D units. Without centralization, integration of geographically dispersed

R&D capabilities for development of global products won't be possible, and the goal of gaining efficiency through offshoring of R&D would be compromised. On the other hand, without formalization, effectively orchestrating the efforts of globally dispersed and interdependent R&D teams won't be possible. The findings showed that both communication and socialization between firm headquarters and the offshore R&D units facilitated generation of innovations by the offshore R&D units. High degree of communication between the offshore R&D units and firm headquarters also alleviated to some extent the issue of distance from customers and markets for the offshore R&D units.

Interestingly, however, the cross-case analysis showed that despite strong centralization there had been instances of major innovations across the offshore R&D engagements studied. Leading examples included Cluster File System (CFS) and Dynamic Multipathing (DMP) Technology generated by VERITAS's offshore R&D unit, Pentagon's Video Broadcast Server innovated by Excel, and ISS' Integrated Digital Security Solutions Platform developed by LTL. An analysis of these and other innovations suggested that five different attributes associated with the offshore R&D engagements influenced the ability of the offshore R&D units to generate incremental and radical product innovations: (1) degree of autonomy of the offshore R&D units in R&D task performance, (2) the ability of headquarters to 'challenge' offshore R&D teams with stretch R&D goals, (3) the ability of offshore R&D teams to take initiatives in response to challenges and opportunities, (4) absence of 'heritage' effects at offshore R&D units, and (5) the desire of offshore R&D team members to prove their credibility and achieve parity with headquarters R&D teams. The findings suggested that 'inequality' existed between firm headquarters and offshore R&D units, and in most cases the inequality served as a source of tension between the two parties. However, the case studied showed that some headquarters managers were able to gainfully leverage the existential tension to catalyze high performance innovations at the offshore R&D units, as exemplified by the cases of CFS and DMP technologies at VERITAS.

The findings suggested that even though the offshore R&D units performed product development and incremental R&D activities, they performed work of complex nature. Often, the R&D tasks assigned to the offshore R&D units specified the desired outcomes at a very high-level, and addressing such tasks required considerable creativity on the part of the offshore R&D units. The cross case findings showed that by offshoring R&D firms not only freed-up R&D capacity at headquarters to pursue new and exploratory innovation tasks but also expanded their overall R&D capacity. This allowed the firms to simultaneously pursue a wide variety of R&D activities at low costs and achieve ambidextrous R&D capability. Surprisingly, however, the offshore R&D engagements studied did not exhibit an explicit emphasis on transfer of knowledge from the offshore R&D units to firm headquarters. Low differential stock of knowledge at the offshore R&D units appeared to be the primary reason for this. The findings related to offshoring of R&D and organizational flexibility revealed that without exception all the studied firms leveraged offshoring of R&D for operational flexibility. Case study findings also showed that some firms leveraged offshoring of R&D for structural flexibility (VERITAS and Frontier) and strategic flexibility (VERITAS and Cordys) to enhance their adaptive capacity. The findings also confirmed the conjectured interrelationship between organizational flexibility and innovative capability. As the case studies indicated, almost all the firms leveraged offshoring of R&D to pursue innovative activities to achieve congruence with the demands of their environment, and at the same time, utilized the organizational flexibility endowed by the offshore R&D units to reinforce their innovative capability.

Finally, several propositions can be drawn from the cross-case analysis, which may be tested to further understand the link between offshoring of R&D, and firm innovative capability and organizational flexibility. Table 7.8 captures all the major propositions that resulted from the cross-case analysis.

Table 7.8: Propositions Derived from Cross-Case Analysis

No.	Propositions
P1	**Offshoring of R&D is positively associated with the innovative capability of the firm.**
P1.1	High levels of centralization for coordination of offshore R&D activities will positively influence the firm’s innovative capability.
P1.2	Moderate levels of formalization for coordination of offshore R&D activities will positively influence the firm’s innovative capability.
P1.3	High levels of communication between headquarters and offshore R&D unit will facilitate innovation generation by the offshore R&D unit and enhance the firm’s innovative capability.
P1.4	The higher the inclusivity of the offshore R&D unit, the greater will be its ability to generate innovations and enhance the firm’s innovative capability.
P1.5	The offshore R&D unit’s ability to generate innovations is directly associated with the nature and scope of innovative tasks allocated to it.
P1.6	High levels of autonomy of offshore R&D units for performance of R&D tasks will positively influence the firm’s innovative capability through generation of innovations.

Table 7.8: Propositions Derived from Cross-Case Analysis (…Continued)

No.	Propositions
P1.7	The ability of the firm headquarters to challenge the offshore R&D unit with meaningful and stretch R&D goals will facilitate generation of innovations by the offshore R&D unit.
P1.8	The ability of the offshore R&D unit to take initiatives to address innovation opportunities will facilitate its ability to create innovations and contribute to the firm's innovative capability.
P1.9	Existence of inequality between the offshore R&D unit and firm headquarters will increase the propensity of the offshore R&D unit to generate innovations.
P1.10	The greater the ability to harness the differences in cognitive styles between the offshore R&D unit and firm headquarters, the higher will be the firm innovative capability.
P1.11	The higher the exploitation of cross-group synergy at the offshore R&D unit, the greater will be its ability to contribute to the firm's innovative capability.
P1.12	The higher the knowledge differential between the offshore R&D unit and firm headquarters, the greater will be headquarters propensity to transfer knowledge from the offshore R&D.
P1.13	The greater the relevance of the offshore R&D unit's stock of knowledge, the greater will be the propensity of firm headquarters to transfer knowledge from the offshore R&D.
P1.14	Offshoring of R&D is positively associated with innovation speed.
P2	**Offshoring of R&D is positively associated with the organizational flexibility of the firm.**
P2.1	Offshoring of R&D will positively influence the firm's operational flexibility.
P2.2	Offshoring of R&D will positively influence the firm's structural flexibility.
P2.3	Offshoring of R&D will positively influence the firm's strategic flexibility.
P2.4	The higher the flexibility of offshore R&D resources, the greater will be the firm's organizational flexibility.
P2.5	The greater the firm's ability to reconfigure and redeploy the offshore R&D resources, the greater will be the firm's organizational flexibility.

CHAPTER 8
DISCUSSION AND CONCLUSION

OFFSHORING OF R&D is a relatively recent and still emerging phenomenon, and is being rapidly embraced by high technology firms of all sizes (UNCTAD, 2004b, 2005; Doz, *et. al.*, 2006; Bardhan, 2006). However, despite its growing significance for the innovation processes of high technology firms, the scholarly literature on offshoring of R&D is yet to develop. This research, therefore, set out to explore the terrain of the phenomenon of offshoring of R&D. Specifically, the research focused on understanding the link between offshoring of R&D and the firm's innovative capability and organizational flexibility. With an emphasis on the analysis of practice, the study employed an interpretive research approach with inductive logic and leveraged a multiple case study design. In total, the empirical inquiry included 8 in-depth case studies with substantial variation across the cases. Comparison of cases showed several similarities and dissimilarities between and among them, and revealed patterns that provided answers to the specific questions that this research aimed to find.

The purpose of this final chapter is to discuss the main findings of the research, and provide answers to the research questions that constituted the objectives of this inquiry. The chapter also describes the contributions of the research to theory and practice. In addition, the limitations of the study and future research directions are discussed. The chapter is organized as follows: First, Section 8.1 presents the main findings of the study and provides answers to the research questions. Next, the contributions of the research to theory and practice are described in Sections 8.2. The limitations of the study are discussed in Section 8.3, and the future research directions are outlined in Section 8.4. The chapter concludes with a summary of the overall conclusions and contributions of the study.

8.1 DISCUSSIONS OF THE MAIN FINDINGS

This section presents the main findings of the research and provides answers to the research questions. Based on the findings of the empirical study, first 'Offshoring of R&D' is characterized. Then, the main findings related to organization and management of offshoring of R&D and its link with the firm's innovative capability and organizational flexibility are discussed. The discussion also illuminates on why some offshore R&D engagements are more effective than the others, and how managers can optimally leverage offshoring of R&D for innovative capability and organizational flexibility. Finally, the intra-firm offshoring of R&D is compared and contrasted with inter-firm offshoring of R&D.

8.1.1 Offshoring of R&D, Its Organization and Management

Drawing on the findings of the extensive empirical research, this section provides the answer to the first main research question (Question Number 1A) that motivated this study: How do firms organize and manage offshoring of R&D for innovative capability and organizational flexibility? In addition, a basic question raised in the study is also addressed: What is Offshore R&D? (Question Number 5).

Within the realm of globalization, 'Offshore R&D' has emerged as a new organizational form. This research found that offshoring of R&D represents a new wave of R&D globalization that has been triggered by the intensifying competitive needs for efficiency and access to talent. This new wave of R&D globalization appears to be markedly different from the previous two waves that were characterized by market-seeking and technology-seeking motives, respectively. Interviews with managers across the case study firms indicated that offshoring of R&D was done primarily to access R&D resources in large scale at relatively lower cost structures ($1/4^{th}$ to $1/6^{th}$ of the costs in USA/Western Europe) to enhance innovation capacity and gain R&D efficiency. Firms either transferred some of their existing R&D activities to an offshore R&D organization or expanded their overall portfolio of R&D activities by utilizing offshore resources. The empirical inquiry revealed a very important dimension of offshoring of R&D: that offshoring can either involve migration or expansion (or both) of R&D activities by a firm from a high cost country to a low cost country. Also, case studies representing diverse industry sectors described in Chapter 6 highlighted that while low cost was a necessary condition, being able to access knowledge resources in large scales formed the sufficient condition for offshoring of R&D. Thus, offshoring of R&D represents a combination of efficiency-seeking and resource-seeking strategies for globalization of R&D.

These findings are revealing because the limited public discourse on the phenomenon has viewed offshoring of R&D as involving only migration or transfer of R&D jobs/activities to a low cost country (Carmel and Tjia, 2005; Inkpen and Ramaswamy, 2006; Cohen, 2007). Moreover, most discussions of the phenomenon underscore low cost structures as the underlying motive and hence consider offshoring of R&D primarily as an efficiency-seeking (cost reduction) strategy for globalization of R&D (see, for example, Carmel and Tjia, 2005; Cohen, 2007). Thus, rooted in empirical regularities and observations of real organizations, our findings clarify the actual contours of the phenomenon and the economic motives underlying it.

Drawing on extensive case studies, Figure 8.1 depicts the characteristics and organization of offshoring of R&D.

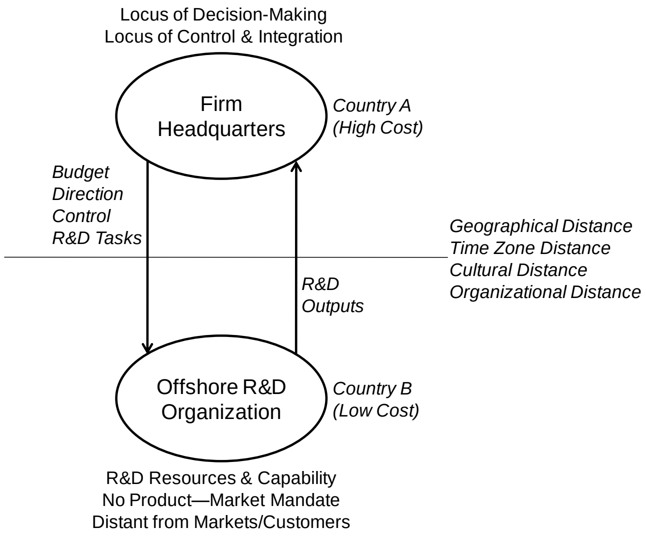


Figure 8.1 Characteristics of Offshore R&D

As shown in the figure, offshoring of R&D is enacted as an engagement between the firm headquarters and an offshore R&D organization (a subsidiary of the firm or another company). In this dyadic relationship, the offshore R&D organization performs specified R&D activities for the firm headquarters under a 'contractual' agreement. The case studies indicated that offshore R&D organizations do not have any product-market mandate as well as proximity to customers and markets. As such, offshore R&D organizations do not have ownership for any product or product line, nor do they typically address needs of local customers and markets. Instead, offshore R&D organizations carry out parts of the firm's overall R&D value chain activities (e.g., development of product components and features, or product variants) assigned to them by headquarters. Outputs produced by offshore R&D organizations are integrated by firm headquarters into their overall R&D/product value chains.

In offshoring of R&D, the locus of decision-making as well as the locus of control lies at firm headquarters. Also, the resource and budget levels as well as the R&D tasks for offshore R&D organizations are determined by firm headquarters. In addition, firm headquarters provide directions and oversight for the activities performed at offshore R&D organizations. Thus, the findings suggested that firms use centralization as the primary tool for managing offshore R&D organizations. Firms also use high degree of communication to facilitate effective coordination and integration of offshore R&D units. In addition, formal review and reporting mechanisms and documented R&D

procedures are used to varying degrees for monitoring and integrating offshore R&D activities. Promotion of social interactions among headquarters and offshore R&D organization members to facilitate exchange of knowledge and development of shared values and goals through job rotation programs, cross-location task forces and committees, and travel between two locations is also common but not necessarily extensive.

The use of a combination of centralization, formalization, communication, and socialization in coordination and integration of offshore R&D organizations resonates with the reported practices for management of globally distributed R&D subsidiaries in multinational corporations (e.g., Bartlett and Ghoshal, 2002; Nobel and Birkinshaw, 1998). But the high degree of centralization in management of offshore R&D organizations is in contrast with the received wisdom, which suggests that excessive centralization negatively impacts performance of global R&D subsidiaries. The choice of coordination mechanisms for management of global R&D subsidiaries depends on the context and purpose of subsidiaries. Most of the literature on globalization of R&D has investigated subsidiaries with product-market mandates or technological centers of excellence, and accordingly concluded that excessive centralization constrains subsidiary performance. On the other hand, an analysis of real success stories suggests that centralized coordination and control eventually contributes to the success of multinational firms as a whole (Birkinshaw, 2003).

In offshoring of R&D, the emphasis on achieving efficiency leads to the use of centralization as the primary approach for managing offshore R&D organizations. Also, since offshoring involves decomposition and distribution of R&D value chain activities, centralized control and integration becomes necessary for value realization. Our study found that the need for centralization becomes pronounced especially because of the interdependencies between firm headquarters and offshore R&D organizations that arise from the distributed nature of the R&D activities. The focus on efficiency also explains why despite its established primacy, the use of socialization in management of offshore R&D organizations is not extensive. Socialization costs money and excessive use of socialization may offset the cost benefits achieved through offshoring of R&D. Thus, our findings illuminate on issues of organizational structure for the unique context of management of globally distributed R&D, where geographically, organizationally, and culturally distributed organizations participate in creation of innovations. These findings are important because the extant literature has not specifically addressed issues of organizational structure for distributed and participatory R&D activities, especially when achieving efficiency through globalization is of importance.

An analysis of task allocation practices revealed that typically firms offshore incremental R&D activities (more of ‘r’ & ‘D’ than ‘R’&’D’) that do not require knowledge of specific business domains. Accordingly, the evidence showed that offshore R&D organizations generate innovations that are incremental in nature. The relatively low cost of technical resources at offshore R&D organizations allows firms to access greater number of R&D resources for the same budget. Thus, by offshoring R&D firms gain access to additional R&D capacity for the same budget. How do firms leverage this additional R&D capacity? The findings of this research indicate that firms leverage the additional R&D capacity for a wide variety of innovative activities spanning development of product components and features, creation of product variants, enhancement and transformation of existing products, and renewal of products through incorporation of new technologies. The data pointed out that firms also offshore a small percentage of exploratory R&D activities to carry out experimentation and prototype development at low costs. In addition, the case studies suggested that firms leverage offshoring of R&D to accelerate innovation speed by (a) leveraging the additional R&D capacity to simultaneously pursue greater number of innovative activities within the same time interval and (b) extending the engineering hours per day.

The research revealed that by shifting incremental innovation activities to offshore R&D organizations, firms are able to reduce the cost of product development, which, in turn, allows them to achieve a lower TCO (total cost of ownership) of products and also gives some leeway in competitive product pricing. Both the reduced TCO of products and the ability to flex product pricing influence the competitiveness of firms. In addition, it appears that generally the technical resources at offshore R&D units do not necessarily possess unique knowledge or capabilities. However, they are nevertheless valuable because they permit firms to build a portfolio of technology resources required to pursue a wide variety of innovative activities. Many of the case study companies maintained slack resources at offshore R&D units for addressing emergent innovation requirements/opportunities or for exploratory R&D activities because such resources were available at low costs. Notably, by moving incremental innovation activities offshore, firms strategically free-up R&D capacity at headquarters for pursuing exploratory innovation activities aimed at developing new technologies and products. Thus, by leveraging offshoring of R&D, firms gain the ability to simultaneously pursue both exploitative (incremental) and exploratory (radical) innovations.

These findings are important because they offer insights into how globally distributed R&D can be strategically leveraged for competitive advantage. For example, the innovation literature suggests that ambidexterity—the ability to simultaneously pursue incremental and radical innovation is the key to the competitive advantage of high technology firms (March, 1991; Tushman and O'Reilly, 1996). Our findings suggest ways in which firms can achieve ambidexterity by harnessing globally distributed R&D. Similarly, the extant literature views R&D globalization as a vehicle for achieving innovation speed (e.g., Doz, *et. al.*, 2001; Gassmann and Zedtwitz, 1998), but it does not illuminate on how firms can actually accelerate innovation speed by leveraging globally distributed R&D. Also, the studies on innovation speed have primarily focused on unitary organizational contexts (e.g., Kessler and Chakrabarti, 1996). The present study shows how firms can improve innovation speed through globally distributed R&D. Thus, by providing insights into micro practices of task allocation, our research illuminates on how firms can create and capture value through offshoring of R&D (Lepak, *et. al.*, 2007; Sirmon, *et. al.*, 2007). Our findings also support the assertion that even if resources at globally distributed R&D subsidiaries are not unique, they are nevertheless valuable for the firm's competitive (Medcof, 2000).

Interviews with managers at the companies studied indicated that firms extensively leverage offshoring of R&D for organizational flexibility. Specifically, and primarily, firms derive operational flexibility by exploiting offshore R&D organizations to quickly and easily ramp-up and ramp-down resources on R&D projects in accordance with emergent needs. We found that some firms leveraged offshoring of R&D more strategically to install new or temporary organizational structures to rapidly achieve congruence with demands of their external environment at low costs. Similarly, the case studies also offered some evidence that firms utilize low cost R&D capacity of offshore units to develop portfolio of options for strategic flexibility, to incorporate new technologies for fundamental renewal of existing products, and to initiate new technological learning trajectories in anticipation of changes in the technological and market environments. Interestingly, the study discovered that offshoring of R&D also provides cultural and cognitive flexibilities (arising from cultural and cognitive differences), which firms capitalize on for innovation speed and variety. While organization theorists and strategic management scholars have extensively studied organizational flexibility (e.g., Volberda, 1996; Evans, 1982; Sanchez, 1995), surprisingly the literature on R&D globalization has not specifically addressed issues of organizational flexibility despite its central role in the modeling of multinational enterprises (Buckley and Casson, 1998). This research provides detailed perspectives on the flexibility enhancing potential of globally distributed R&D.

Our research found that the scope and contributions of offshore R&D units co-evolve over a period of time with their own capabilities, initiatives and relationship with firm headquarters. The findings revealed that several sources of tension exist in offshore R&D engagements. First, managers at firm headquarters expect offshore R&D units to demonstrate levels of expertise and R&D productivity at par with headquarters R&D organization right from the beginning of the engagement, not recognizing that their own capabilities developed in a path-dependent fashion over a period of time. Second, offshore R&D units often have aspirations that don't match their current capabilities, and at times this causes conflict between what is expected of them versus what they want to pursue. Third, the cases suggested that when offshoring involves migration of R&D activities from headquarters to offshore R&D units, it causes fear of threat of jobs among people at firm headquarters and affects their attitude towards and cooperation with offshore R&D units. Fourth, lack of visibility into the decision-making processes of headquarters and empowerment for task performance also adds to the tension in the relationship between firm headquarters and offshore R&D units. The observations related to the evolving nature of offshore R&D engagements find support in previously published studies that examined evolution of multinational subsidiaries (e.g., Birkinshaw and Hood, 1998). However, the micro-dynamics of the relationship between firm headquarters and offshore R&D organizations are very different and unique compared to the traditional headquarters – subsidiary relationships.

8.1.2 Offshoring of R&D, Firm's Innovative Capability and Organizational Flexibility

This section provides the answer to the second main research question (Question Number 1B) that formed the core of this study: How is offshoring of R&D associated with the firm's innovative capability and organizational flexibility? The section also embeds answers to two associated questions (Question Numbers 2 and 3): Why do offshore R&D engagements differ in their endowments of innovative capability and organizational flexibility? How can high technology firms optimally leverage offshoring of R&D for innovative capability and firm flexibility?

Analysis of processes and practices used by firms in organizing and managing offshore R&D engagements led to a normative model linking offshoring of R&D and the firm's innovative capability and organizational flexibility. The model, built by drawing on the cross-case analysis in Chapter 7, is shown in Figure 8.2. As the model suggests, there are several determinants of innovative capability and organizational flexibility in offshoring of R&D. Some of these determinants pertain to the structural characteristics of the offshore R&D engagement, whereas the others are related to the attributes of the offshore R&D organization and capabilities of the firm. In what follows, the normative model is discussed in detail.

This research conceptualized that offshoring of R&D offers dual paths to the firm's innovative capability: (a) creation of innovative outputs by offshore R&D units and (b) knowledge transfer from offshore R&D units to firm headquarters facilitating new innovations through knowledge combination. The performance of the first path—creation of innovative outputs by offshore R&D units—depends on how offshore R&D units are governed. As discussed earlier, we found that firm headquarters used high degrees of centralization to manage offshore R&D organizations. This practice is in contrast with the received wisdom, which suggests that excessive centralization negatively impacts the ability of globally distributed R&D units to create innovations (Ghoshal and Bartlett, 1988; Persaud, *et. al.*, 2002).

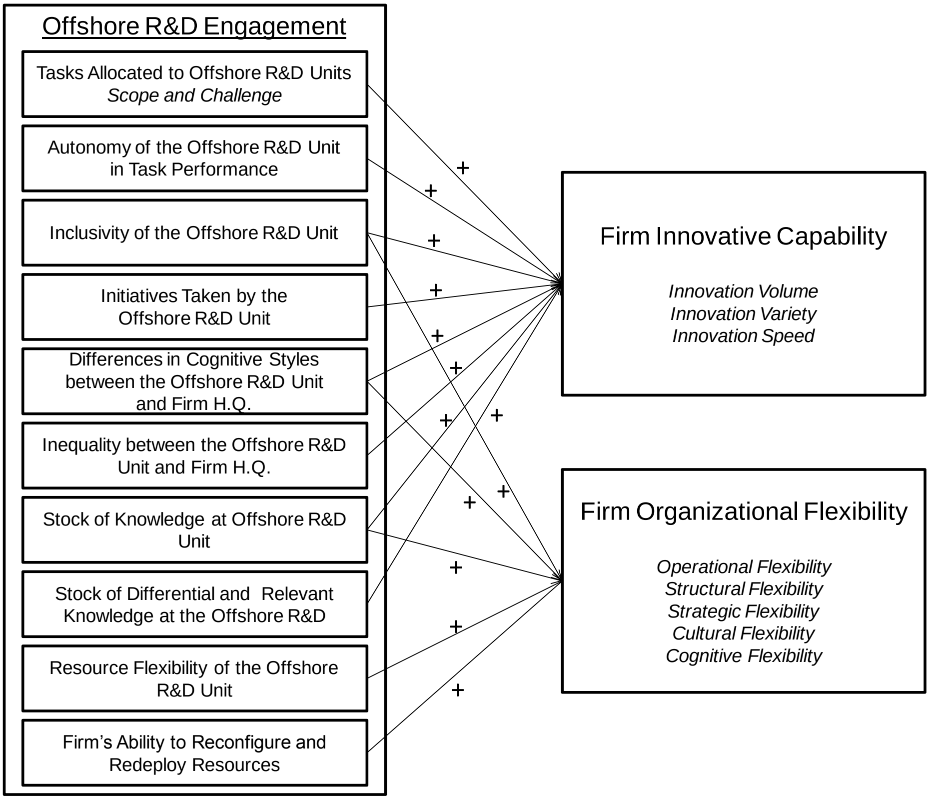


Figure 8.2: Offshoring of R&D, Innovative Capability, and Organizational Flexibility

Interestingly, however, we found that despite strong centralization, offshore R&D units routinely created valuable innovative outputs. The case studies suggested that while centralization is essential for efficient and effective coordination and integration of offshore R&D activities, autonomy for task performance can greatly facilitate the ability of offshore R&D organizations to contribute innovative outputs. We found several instances of major innovations contributed by offshore R&D organizations even when they did not have the autonomy to decide their R&D projects. An investigation of enablers associated with these innovations suggested that the offshore

R&D teams had full autonomy for task performance (freedom to make product design decisions and choose technical directions). We found that firms embrace ownership-based task allocation approaches to grant offshore R&D units the autonomy for task performance. The findings suggested that autonomy for task performance empowers people at offshore R&D organizations, builds ownership, motivates them to engage in creative problem-solving, and also establishes accountability for performance. Mudambi, *et. al.* (2007) reached a similar conclusion in their study of global R&D subsidiaries of multinational companies.

The cross-case analysis indicated that the ability of offshore R&D units to generate innovative outputs depends on the nature of R&D tasks allocated to them. The higher the innovative scope of tasks assigned to offshore R&D units, the higher will be their ability to generate innovative outputs. Similarly, the research revealed that when headquarters managers are able to challenge offshore R&D team members with stretch goals, it energizes them, stimulates their creativity, and leads to generation of significant innovative outputs. These findings are not counter-intuitive. According to Mohr (1969), two conditions must be met for innovation creation—feasibility and desirability. Allocation of innovative R&D tasks to offshore R&D organizations fulfills the feasibility condition, whereas challenging the offshore RR teams with stretch R&D goals meets the condition for desirability.

The empirical research showed that firms used high degrees of communication and varying degrees of socialization to coordinate and integrate offshore R&D units. We found that when headquarters demonstrate high levels of inclusivity in managing offshore R&D units through frequent communications and socialization, it facilitates the ability of offshore R&D units to understand parent firms' innovation needs and effectively respond to them. Inclusivity facilitates greater integration of offshore R&D units with firm headquarters and catalyzes flow of information and knowledge. Greater exchange of information and knowledge allows offshore R&D units to identify innovation opportunities and take initiatives to address them. This was not surprising as it is already well accepted that informal coordination mechanisms like communication and socialization greatly facilitate the ability of global R&D units to produce innovations (Ghoshal and Bartlett, 1988; Allen, 1977; Gupta and Govindarajan, 2000; Brockhoff and Medcof, 2007). We found that inclusivity positively influences the cooperative behavior and responses of offshore R&D organizations and facilitates organizational flexibility through their adaptive postures. This observation founds support in the procedural justice theory (Kim and Mauborgne, 1991, 1998).

The investigations also revealed that the ability of offshore R&D units to take meaningful initiatives positively influences the innovative capability of firms. We found several instances of highly valuable innovations produced by offshore R&D organizations, roots of which could be traced to initiatives taken by leaders at offshore R&D organizations. A combination of intrinsic motivation (the desire to generate innovations) and extrinsic motivation (to demonstrate capability to headquarters), facilitated by high degree of inclusivity, enabled these initiatives and their success. These observations find support in the literature on MNS subsidiary management (Birkinshaw, *et. al.*, 1998; Mudambi, *et. al.*, 2007).

Our study also revealed that when managers tactfully exploit the inequality between offshore R&D units and headquarters R&D organizations, offshore R&D units produce significant innovative outputs. In offshoring of R&D, inequality of offshore R&D units is inevitable, and arises primarily from their lack of autonomy. Inequality also exists due to differences of experiences, knowledge stocks and status between firm headquarters and offshore R&D units. We found that inequality is both a source of tension in the relationship between offshore R&D units and firm headquarters, and at the same time, a springboard for innovation initiatives by offshore R&D units. Inequality stimulates creativity and increases the propensity of offshore R&D units to generate innovations so as to achieve parity with headquarters R&D organizations through demonstrated performance. This research also found that the ability of firms to leverage the differences in cognitive styles between headquarters R&D organizations and offshore R&D organizations facilitates generation of innovation and creation of new knowledge. The differences in cognitive styles primarily arise from differences in the path dependencies of learning trajectories of two locations. Our finding lends empirical support to the assertion that systematic exploitation of cognitive differences has the potential to improve the innovative capability of the firm (Leonard, 1995).

This research found that offshore R&D units' stock of knowledge also has a direct association with the innovative capability of firms. If the stock of offshore R&D units' knowledge is duplicated (that is, similar to that of firm headquarters), the firm's innovative capability is enhanced through cross-fertilization and exploitation of cross-group synergies. We found that duplicated stock of knowledge at offshore R&D units also facilitates organizational flexibility by allowing firms to move innovation activities from headquarters to offshore R&D units, and vice versa. On the other hand, when offshore R&D units possess diverse and specialized knowledge, innovative capability of the firm is enhanced through knowledge combination leading to generation of new innovations. These findings are supported by empirical research reported in the literature on R&D globalization (Zander, 1999).

The case studies indicated the efficacy of the second path to the firm's innovative capability—the knowledge transfer path—to be generally weak across the cases. Our findings suggest that the transfer of knowledge from offshore R&D units to firm headquarters primarily depends on differential stock of knowledge possessed by offshore R&D units and its relevance to firm headquarters. Accordingly, if the stock of knowledge of offshore R&D units is duplicated, firm headquarters will be less inclined to transfer knowledge from them. On the other hand, when offshore R&D units possess diverse and specialized stocks of knowledge, the motivation of firm headquarters to transfer and integrate knowledge from them will be high, provided the knowledge is also relevant to them. Our observation finds support in a recent piece of research that investigated knowledge sourcing in the context of headquarters-subsidiary relationships (Song and Shin, 2008).

The findings of the research showed that firms employ variety of mechanisms for knowledge transfer and integration in offshore R&D engagements. These include codification (documentation), social interactions (cross-location task forces and committees), and embodied outputs (product components and features). However, this research could not assess the extent and nature of knowledge transferred through social interactions. We also found that the patterns of task allocation to offshore R&D units influence their learning trajectory and thereby their stock of knowledge.

This research shows that offshoring of R&D serves as an adaptive device that permits firms to build a repertoire of flexibility enhancing options to hedge against future uncertainties. As discussed earlier, the ability of firms to leverage offshore R&D units for organizational flexibility depends on the flexibility of resources at offshore R&D units and the ability of firms to reconfigure and redeploy the offshore R&D resources both in a proactive and reactive manner. When offshore R&D units possess resources with versatile skills and capabilities, they offer higher resource flexibility because versatile resources can be deployed for a variety of R&D tasks. Likewise, when offshore R&D units have a combination of duplicated and specialized stock of knowledge, they are able to endow firms with organizational flexibility by simultaneously addressing a variety of innovation goals. This study found that firms exploit low cost and large scale of offshore R&D resources to enhance their reactive as well as adaptive capacity. Our findings provide empirical support to discussions in the strategic management literature on organizational flexibility (Volberda, 1996; Sanchez, 1995; McGrath, 2001).

This research surfaced many paradoxes that managers need to deal with in organizing and managing offshoring of R&D. For example, in order to reduce the costs associated with communication and coordination, firms allocate tasks to offshore R&D units in such a way that the interdependencies between the two locations are minimized. However, reduced interdependencies mean reduced interactions between the two locations, and thus affect the prospects for organizational learning and knowledge transfer. Similarly, the development of offshore R&D units’ stock of knowledge and capabilities depends on the types of tasks allocated to them. Task allocation can facilitate development of specialized knowledge or reinforce generic R&D skills and competencies. When task allocation supports development of specialized knowledge, a learning trajectory locked in a specific technological paradigm is initiated. While such specialized, path-dependent knowledge can significantly influence the innovative capability of firms, it may also lead to cognitive rigidity and inertia at offshore R&D units. On the other hand, task allocation that reinforces development of generic, multi-purpose R&D capabilities and duplicated knowledge at offshore R&D units confers higher organizational flexibility.

8.1.3 Intra-firm versus Inter-firm Offshoring of R&D

This section illuminates on the third associated research question (Question Number 4): How does intra-firm offshoring of R&D compare and contrast with inter-firm offshoring of R&D as regards firm innovative capability and organizational flexibility?

This research found that the innovative outputs produced by captive (intra-firm) offshore R&D units are comparable to those produced by offshore R&D outsourcing partners (inter-firm). The organizational factors that underlie the ability of the two types of offshore R&D units to create innovative outputs are also the same. However, the two modes of offshoring of R&D differ in terms of their knowledge stocks and endowments of organizational flexibility. The findings indicate that offshore R&D outsourcing partners provide a wide range of R&D skills and capabilities, including complementary capabilities, critical for pursuit of innovative projects. We found that firms access these resources with diverse skills and capabilities on demand without having to invest in hiring and developing them. In a sense, R&D resources of outsourcing partners are akin to slack that firms deploy on new innovation projects. Interviews with managers at case study companies also suggested that R&D outsourcing partners deploy knowledge and experience gained from other customer projects to deliver improved innovation performance.

However, the findings indicated that firms pursue inter-firm offshoring of R&D only for repeatable or stand-alone innovation tasks primarily to reduce their fixed R&D costs and gain operational flexibility. We found that operational flexibility offered by a captive offshore R&D unit is relatively less compared to an offshore R&D outsourcing vendor. Perspectives gathered from managers at the case study firms suggested that intra-firm offshoring of R&D is more appropriate when (a) task interdependencies between two locations is high, (b) innovative scope of the project is high, (c) nature of knowledge associated with the innovation is new and critical for competitiveness of firms, and (d) long-term capability building is crucial. This research did not find strong support for the core competence based (Prahalad and Hamel, 1990; Quinn, 1999) approach to task allocation for R&D outsourcing. Instead, we found that the ability to gain flexibility for effectively addressing technological and market uncertainties, combined with the need to contain fixed R&D costs, was at the core of offshore R&D outsourcing engagements studied. However, the study found support for the argument that firms benefit when they outsource autonomous, and not systemic, innovations (Chesbrough and Teece, 1996).

8.2 Contributions of the Research

This research offers new and important contributions to theory and practice related to globalization of R&D. In this section, the contributions of the research are described. Contributions to theory are discussed in Section 8.2.1, whereas Section 8.2.2 captures the contributions to managerial practice.

8.2.1 Contributions to Theory

This research makes several important contributions to the literature on globalization of R&D in general and offshoring of R&D in particular. Offshoring of R&D is a relatively recent phenomenon, and the academic literature on the subject is in its very early stages of development. Scholars have only recently begun to highlight the need for scholarly research on the phenomenon of offshoring of R&D (Bardhan and Jaffee, 2005; Jensen and Pedersen, 2007; Mudambi, 2007). This study represents one of the first systematic attempts to develop a comprehensive understanding of the terrain of offshoring of R&D. Specifically, the research provides grounds-up perspectives on (a) how high technology companies organize and manage offshoring of R&D and (b) how offshoring of R&D links with the firm's innovative capability and organizational flexibility—the two most important capabilities for the competitive success of high technology firms. The rapid growth in offshoring of R&D activities warrants a systematic understanding of its influence on the firm's competitiveness. Thus, this research makes new and important contributions by providing a descriptive and explanatory theory that illuminates the link between offshoring of R&D and the firm's innovative capability and organizational flexibility. In addition, based on extensive empirical research, this research characterizes the phenomenon of offshoring of R&D, and also makes a further contribution by studying both intra-firm and inter-firm offshoring of R&D.

In the larger context of globalization of R&D, of which offshoring of R&D is a part, this research makes many important contributions. First of all, the extant literature mostly concerns market-seeking or technology-seeking motive of firms in globalization of R&D, whereas this research addresses a new form of R&D globalization that is motivated by combined motives of gaining efficiency and knowledge resources. Accordingly, this research adds to the literature by providing insights on organizational and management processes, as well as outcomes, associated with efficiency- and resource seeking globalization of R&D. Second, despite the long-felt need for studying organizational and management processes associated with globalization of R&D (Cheng and Bolon, 1993), most studies have tended to focus on cross-sectional analysis or economic aspects of the phenomenon (Gassmann and von Zedtwitz, 1999). With its focus on organizational and management processes, this research contributes to addressing the gap. Third, despite organizational flexibility being central to the modeling of multinational enterprises (Bartlett and Ghoshal, 2002; Buckley and Casson, 1998), prior research has not specifically examined the link between globalization of R&D and organizational flexibility. This study makes an important contribution by addressing this gap.

Fourth, most scholarly work on innovation has focused on unitary organizations (Nohria and Ghoshal, 1997), and studies that deal with generation of innovation in the context of globalization of R&D are still small in number. Moreover, those studies that have investigated aspects related to generation of innovations in globally distributed R&D have focused on subsidiaries of multinational firms with product-market mandates (e.g., Ghoshal and Bartlett, 1988; Nobel and Birkinshaw, 1998). Research on globalization of R&D has not addressed situations in which a geographically distributed R&D unit participates with firm headquarters to create innovations (Ghoshal and Bartlett, 1988). Thus, this research makes important contributions to the literature on R&D globalization by addressing not only the aspects related to globally distributed generation of innovations but also enlightening on participatory creation of innovations in global R&D. Fifth, except for one notable exception (Venaik, *et. al.*, 2005), innovation studies in R&D globalization have either investigated the link between organizational structure and innovation performance, or examined the processes of knowledge transfer and integration as an antecedent to innovation generation. This research represents one of the rare studies that examine the dual paths to innovative capability: (a) organizational structure—innovation generation and (b) knowledge transfer and combination.

Sixth, most studies on R&D globalization have examined transfer of knowledge from firm headquarters to global subsidiaries, or among subsidiaries. With the exception of a few authors (e.g., Frost and Zhou, 2005), the extant literature has not investigated knowledge transfer from subsidiaries to firm headquarters. This research makes an important contribution to the literature by examining transfer of knowledge from a subsidiary (offshore R&D unit) to the firm headquarters. Seventh, from a strategic management perspective, this study views offshore R&D as a new, global organizational form. By examining the link between offshoring of R&D and the firm's innovative capability and organizational flexibility—the two most important dynamic capabilities—this study also makes an important contribution to the strategic management literature by exploring how offshoring of R&D influences the firm's dynamic capabilities. Eighth, from a methodological point of view, this research is one of the few ideographic studies that explore innovative capability and organizational flexibility of the firm within the broader context of R&D globalization. Indeed, the study represents one of the few early applications of the interpretive research approach aimed at exploring the terrain of a macro phenomenon like offshoring of R&D.

Finally, as discussed earlier, innovative capability and organizational flexibility are the two most important dynamic capabilities for the competitive success of high technology firms (Teece, *et. al.,* 1997; Eisenhardt and Martin, 2000; Wang and Ahmed, 2007. This research shows that offshoring of R&D is positively linked with the firm's innovative capability and organizational flexibility. Accordingly, it can be said that offshoring of R&D also positively influences the firm's dynamic capabilities. Specifically, this research shows how firms can leverage offshoring of R&D to refresh their competences and effectively adapt themselves to achieve congruence with their environments by integrating and reconfiguring internal and external resources. Thus, from a strategic management perspective, this research makes an important contribution by showing how offshoring of R&D links with the firm's dynamic capabilities.

8.2.2 Contributions to Practice

This research argues that offshoring of R&D is a new global organizational form that has emerged due to decomposition and disaggregation of the firm's R&D value chain. Drawing on empirical regularities and observations of real organizations, this research shows how firms can go beyond structural savings and strategically leverage offshoring of R&D for their competitiveness. With detailed documentation and analysis of organizational and management processes and practices employed by firms across industry sectors, this research provides actionable insights to managers on how to harness comparative advantage through offshoring of R&D to achieve leverageable competitive advantage. Specifically, with focus on analysis of practice, the research advances a normative model to provide guidance to managers on how to leverage offshoring for various activities across the R&D value chain to enhance the firm's innovative capability and organizational flexibility. The research shows that offshoring of R&D can endow a firm with a portfolio of options at low costs, which permits the firm to develop an adaptive capacity as well as ambidexterity—the ability to simultaneously pursue exploitation and exploration—needed for their competitiveness. The study also compares and contrasts intra-firm and inter-firm offshoring of R&D to illuminate managers on when and how a particular mode could be used to meet the firm's competitive needs for innovative capability and organizational flexibility.

8.3 LIMITATIONS OF THE STUDY

Notwithstanding an extensive research design leading to several important contributions, this study is not without its limitations. First of all, although this study sought to develop a normative theory with a wider resonance, care must be exercised while interpreting and applying the findings of this research to settings different than those examined in this research. This research employed a multiple case study design with an interpretive approach. The cases were chosen to ensure maximum variation across them to facilitate generalization. However, all the cases studied pertained to offshoring of software R&D, which is fundamentally different from R&D in other areas. Unlike R&D in other technologies, in software R&D process there is no tooling or manufacturing phase of the product development. Rather, when R&D is finished, the software is ready to use and sell (Tessler and Barr, 1997). Thus, caution is necessary while extending the findings of this study to contexts that represent offshoring of R&D in other technology areas. Also, in this study, all the offshore R&D units studied were located in India, and it is plausible that the findings of this study may show variations in cases of offshore R&D units located in other countries (for example, China) due to differences in the cultural context.

Another limitation of the study is attributable to the approach adopted for data gathering. Even though the firm was the level of analysis in this study, a relatively larger number of informants were interviewed at the offshore R&D units than firm headquarters. The rationale for such an approach was that the focal aspects of the study could be investigated by focusing on offshore R&D units because that's where the 'action' was. Such an approach was similar to the approach adopted by many leading scholars in the field of R&D globalization and multinational management (e.g., Ghoshal and Bartlett, 1988; Birkinshaw and Hood, 1998). However, interviewing a larger number of informants at firm headquarters, covering both senior and operating level executives, would have generated richer and deeper perspectives. Also, due to logistical reasons, most of the informants at firm headquarters were interviewed by telephone, whereas face-to-face interviews could possibly have resulted in more engaging conversations, leading to generation of detailed and deeper insights.

8.4 FUTURE RESEARCH DIRECTIONS

Offshoring of R&D being a relatively recent phenomenon, it offers ample scope to make new scholarly contributions. Particularly related to the focus of this study, several future research opportunities exist. First of all, the present study can be extended and complemented by a quantitative survey of offshore R&D engagements to test the findings of the present study and improve their generalizability. Second, while this study focused on two important capabilities—innovative capability and organizational flexibility—crucial for competitive performance, future research can directly investigate the impact of offshoring of R&D on firm performance (Grevesen and Damanpour, 2007). Third, this research did not assess the differences in the firm's innovative capability and organizational flexibility prior to and as a result of offshoring of R&D. Such a quantitative evaluation is necessary to understand the real impact of offshoring of R&D on firm performance. Similarly, comparison of innovation performance of organizations that offshore their R&D activities with those that do not leverage offshoring offers a promising avenue for further research. Such a comparison could help ascertain the impact of offshoring on innovative capability and organizational flexibility. In a related vein, whilst the findings of this research suggest that offshoring of R&D leads to a greater volume of innovations, it will be interesting and important to examine the impact of offshoring of R&D on the quality of innovations as well (Singh, 2008).

Fourth, longitudinal research studies can be performed to examine how the capabilities, charter, and contributions of offshore R&D organizations co-evolve over a period of time. Such studies will not only reveal the complete dynamics but also the long-term impact of offshoring of R&D on firm performance. Fifth, while the present study did not investigate the sources of innovative capabilities of the offshore R&D units studied, future research can examine where the innovative capabilities of offshore R&D units come from and how do they develop in the first place (Andersson, *et. al.*, 2002). Such studies can also examine the influence of the local environment in which offshore R&D units are embedded. Finally, the present study examined the phenomenon of offshoring of R&D from the point of view of the firm. Future research efforts can include dyadic studies that that can also shed light on how an offshore R&D unit stands to benefit from offshore R&D engagements. Specifically, in cases of inter-firm offshoring of R&D, it will be interesting to understand the benefits accrued to or derived by offshore R&D units, for example, development of their own capabilities as a result of offshore R&D engagements.

8.5 CONCLUSION

This research examined the link between offshoring of R&D and the firm's innovative capability and organizational flexibility. Using a grounds-up research approach focusing on analysis of practice in real organizations, the study found that offshoring of R&D is positively associated with the firm's innovative capability and organizational flexibility. The study showed that offshoring of R&D permits a firm to develop a repertoire of options, which can be gainfully leveraged to improve R&D efficiency, innovation volume and variety, innovation speed, and enhance adaptive capacity. Importantly, offshoring of R&D gives a firms firm higher innovation latitude, facilitates ambidexterity, and serves as an adaptive device that can help effectively address technological and market uncertainties. Whilst further research is required along the lines discussed in Section 8.6, the findings of this exploratory study suggested that offshoring of R&D is a valuable organizational form that enables the firm to achieve competitive advantage rooted in comparative advantage. The study also indicated that offshoring of R&D is a complex, multi-dimensional phenomenon which cannot be fully explained using any single theoretical perspective.

This study represented one of the first systematic attempts to develop a comprehensive understanding of the phenomenon of offshoring of R&D. The study defined and characterized offshoring of R&D, and developed an integrative understanding of the phenomenon of offshoring of R&D, focusing specifically on its link with the firm's innovative capability and organizational flexibility. Besides making new theoretical and practical contributions to shed light on the emerging phenomenon of offshoring of R&D, the research also made valuable contributions to the larger literature on globalization of R&D. In particular, this research is perhaps the only study that specifically examined aspects related to organizational flexibility in the context of R&D globalization. Also, this research represented one of the first studies to address efficiency- and resource-seeking globalization of R&D. It is hoped that this study will provide the foundation for, and stimulate, future research on offshoring of R&D.

REFERENCES

Aaker, D. A. and Mascarenhas, B. (1984). The Need for Strategic Flexibility. *Journal of Business Strategy,* Vol. 5, No. 2, pp. 74–82.

Abbott, A. and Banerji, K. (2003). Strategic Flexibility and Firm Performance: The Case of U.S. Based Transnational Corporations. *Global Journal of Flexible Systems Management,* Vol. 4, Nos. 1&2, pp. 1–8.

Ahuja, G. and Lampert, C. M. (2001). Entrepreneurship in the Large Corporation: A Longitudinal Study of How Established Firms Create Breakthrough Inventions. *Strategic Management Journal,* Vol. 22, pp. 521–543.

Allen, L. and Pantzalis, C. (1996). Valuation of the Operating Flexibility of Multinational Corporations. *Journal of International Business Studies,* Vol. 27, No. 4, pp. 633-653.

Allen, T. J. (1977). *Managing the Flow of Technology*. Cambridge, MA, USA: MIT Press, Sixth Printing (1993).

Almeida, P. and Phene, A. (2004). Subsidiaries and Knowledge Creation: The Influence of the MNC and Host Country on Innovation. *Strategic Management Journal,* Vo. 25, pp. 847-864.

Almeida, P., Song, J., and Grant, R. M. (2002). Are Firms Superior to Alliances and Markets? An Empirical Test of Cross-Border Knowledge Building. *Organization Science,* Vol. 13, No. 2, pp. 147-161.

Amidon Rogers, D. M. (1996). The Challenge of Fifth Generation R&D. *Research • Technology Management,* July–August, pp. 33–41.

Amit, R. and Schoemaker, P. J. H. (2000). Strategic Assets and Organizational Rent. *Strategic Management Journal,* Vol. 14, No. 1, pp. 33–46.

Andersson, U., Forsgren, M., and Holm, U. (2002). The Strategic Impact of External Networks: Subsidiary Performance and Competence Development in the Multinational Corporation. *Strategic Management Journal,* Vol. 23, pp. 979-996.

Archibugi, D. and Michie, J. (1995). The Globalization of Technology: A New Taxonomy. *Cambridge Journal of Economics,* Vol. 19, pp. 121-140.

Archibugi, D. and Iammarino, S. (2002). The Globalization of Technological Innovation: Definition and Evidence. *Review of International Political Economy,* Vol. 9, No. 1, pp. 98-122.

Ariffin, N. and Figueiredo, P. N. (2004). Internationalization of Innovative Capabilities: Counter-Evidence from the Electronics Industry in Malaysia and Brail. *Oxford Development Studies,* Vol. 32, No. 2, pp. 559-583.

Arrow, K. J. (1985). The Economics of Agency. In: *Principals and Agents: The Structure of American Business,* USA, Boston, MA: Harvard University School Press.

Asakawa, K. (2001). Evolving Headquarters-Subsidiary Dynamics in International R&D: The Case of Japanese Multinationals. *R&D Management,* Vol. 31, No. 1, pp. 1-14.

Astley, W. G. (1985). Administrative Science as Socially Constructed Truth. *Administrative Science Quarterly,* Vol. 30, pp. 497–513.

Ayers, A. D. (2005). Industrial Research Institute's R&D Trend Forecasts for 2005. *Research • Technology Management,* January – February, pp. 18–22.

Bacharach, S. B. (1989). Organizational Theories: Some Criteria for Evaluation. *Academy of Management Review,* Vol. 14, No. 4, pp. 496–515.

Baden-Fuller, C., Targett, D., and Hunt, B. (2000). Outsourcing to Outmanoeuvre: Outsourcing Re-defines Competitive Strategy and Structure. *European Management Journal,* Vol. 18, No. 3, pp. 285-295.

Bahrami, H. and Evans, S. (1989). Strategy–Making in High–Technology Firms: The Empiricist Mode. *California Management Review,* Vol. 31, No. 2, pp. 107–127.

Bahrami, H. (1992). The Emerging Flexible Organization: Perspectives from Silicon Valley. *California Management Review,* Vol. 34, No. 4, pp. 33–52.

Balachandra, R. (2005). Outsourcing R&D. *Institute for Global Innovation Management,* Northeastern University, Working Paper No. 05-004, 8 pages.

Baliga, B. R. and Jaeger, A. M. (1984). Multinational Corporations: Control Systems and Delegation Issues. *Journal of International Business Issue*, Vol. 15, No. 2, pp. 25-40.

Banbury, C. M. and Mitchell, W. (1995). The Effects of Introducing Important Incremental Innovations on Market Share and Business Survival. *Strategic Management Journal,* Vol. 16, pp. 161-182.

Bardhan, A. D. and Jaffee, D. M. (2005). Innovation, R&D and Offshoring. *Fisher Center Research Reports,* Haas School of Business, University of California at Berkeley, Paper 1005, 19 pages.

Bardhan, A. D. (2006). Managing Globalization of R&D: Organizing for Offshoring Innovation. *Human Systems Management,* Vol. 25, No. 2, pp. 103-114.

Barney, J. (1991). Firm Resources and Sustained Competitive Advantage. *Journal of Management,* Vol. 17, No. 1, pp. 99–120.

Barringer, B. R. and Harrison, J. S. (2000). Walking a Tightrope: Creating Value through Interorganizational Relationships. *Journal of Management,* Vol. 26, No. 3, pp. 367-403.

Barthêlemy, J. (2003). The Seven Deadly Sins of Outsourcing. *Academy of Management Executive,* Vol. 17, No. 2, pp. 87-100.

Bartlett, C. A. and Ghoshal, S. (2002). *Managing Across Borders: The Transnational Solution*. Boston, MA, USA: Harvard Business School Press (Second Edition).

Becker, M. C. and Zirpoli, F. (2003). Organizing New Product Development: Knowledge Hollowing-out and Knowledge Integration—The Fiat Auto Case.

International Journal of Operations and Production Management, Vol. 23, No. 9, pp. 1033–1061.

Becker, H. S. and Richards, P. (1986). *Writing for Social Scientists: How to Start and Finish Your Thesis, Book, or Article.* Chicago, USA: The University of Chicago Press.

Belderbos, R. and Zhou, J. (2007). On the Growth of Foreign Affiliates: Multinational Plant Networks, Joint Ventures, and Flexibility. *Journal of International Business Studies,* Vol. 38, No. 7, pp. 1095–1112.

Beneito, P. (2006). The Innovative Performance of In-house and Contracted R&D in Terms of Patents and Utility Models. *Research Policy,* Vol. 35, pp. 502-517.

Berg, B. L. (1995). *Qualitative Research Methods for the Social Sciences* (Second Edition). Boston, USA: Allyn and Bacon.

Berger, P. L. and Luckman, T. (1967). *The Social Construction of Reality: A Treatise in the Sociology of Knowledge*. New York, USA: Anchor Books.

Berggren, C. (2004). Global Dreams – Local Teams: Rhetoric and Realities of Transnational Innovation. *International Journal of Innovation Management,* Vol. 8, No. 2, pp. 115-145.

Berglund, H. (2004). Interesting Theories of Innovation: The Practical Use of the Particular. *Chalmers University of Technology, Department of Innovation Engineering and Management Working Paper,* WP # 2004:1, 22 pages.

Bettis, R., Bradley, S., and Hamel, G. (1992). Outsourcing and Industrial Decline. *Academy of Management Executive,* Vol. 6, No. 1, pp. 7-22.

Bhattacharya, A. (2004). Capturing Global Advantage: How Leading Industrial Companies are Transforming Their Industries by Sourcing and Selling in China, India, and Other Low Cost Countries. *The Boston Consulting Group Report,* April, Boston, MA, USA, 50 pages.

Birkinshaw, J. and Morrison, A. J. (1995). Configuration of Strategy and Structure in Subsidiaries of Multinational Corporations. *Journal of International Business Studies*, Vol. 26, No. 4, pp. 729-753.

Birkinshaw, J. (2001). Strategy and Management in MNE Subsidiaries. In: *The Oxford Handbook of International Business,* A. M. Rugman and A. Verbeke (Eds.), UK, Oxford: Oxford University Press, pp. 380-401.

Birkinshaw, J., Hood, N., and Jonsson, S. (1998). Building Firm Specific Advantages in Multinational Corporations: The Role of Subsidiary Initiative. *Strategic Management Journal,* Vol. 19, pp. 221-241.

Birkinshaw, J. and Hood, N. (1998). Multinational Subsidiary Evolution: Capability and Charter Change in Foreign-Owned Subsidiary Companies. *Academy of Management Review,* Vol. 23, No. 4, pp. 73-795.

Birkinshaw, J., Nobel, R., and Ridderstrale, J. (2002). Knowledge as a Contingency Variable: Do the Characteristics of Knowledge Predict Organization Structure? *Organization Science*, Vol. 13, No. 3, pp. 274-289.

Birkinshaw, J. (2003). Future Directions in International Business Research: The MNC, Subsidiary and Host Country Agendas. In: Hood, N. (Ed.), *Multinational Subsidiary: Management, Economic Development and Public Policy*, New York, USA: Palgrave Macmillan.

Birkinshaw, J. (1997). Entrepreneurship in Multinational Corporations: The Characteristics of Subsidiary Initiatives. *Strategic Management Journal,* Vol. 18, No. 3, pp. 207-229.

Birkinshaw, J. (1996). How Multinational Subsidiary Mandates are Gained and Lost. *Journal of International Business Studies,* Vol. 27, No. 3, pp. 467-495.

Björkman, I., Barner-Rasmussen, W., and Li, L. (2004). Managing Knowledge Transfer in MNCs: The Impact of Headquarters Control Mechanisms. *Journal of International Business Studies,* Vol. 35, No. 5, pp. 443-455.

Blaikie, N. (2000). *Designing Social Research*. Cambridge, U.K.: Polity.

Boghani, A., Onassis, J., Benabodji, A., and Bijl, C. (1998). Globalization of R&D. *International Journal of Technology Management,* Vol. 17, No. 6, pp. 696-710.

Boutellier, R., Gassmann, O., and von Zedtwitz, M. (2000). *Managing Global Innovation: Uncovering the Secrets of Future Competitiveness.* Berlin, Germany: Springer–Verlag (Second Revised Edition).

Bowman, E. H. and Hurry, D. (1993). Strategy through the Options Lens: An Integrated View of Resource Investments and the Incremental-Choice Process. *Academy of Management Review,* Vol. 18, No. 4, pp. 760-782.

Bozdogan, K., Deyst, J., Hoult, and Lucas, M. (1998). Architectural Innovation in Product Development through Early Supplier Integration. *R&D Management,* Vol. 28, No. 3, pp. 163-173.

Brockhoff, K. K. L. and Schmaul, B. (1996). Organization, Autonomy, and Success of Internationally Dispersed R&D Facilities. *IEEE Transactions on Engineering Management,* Vol. 43, No. 1, pp. 33-40.

Brockhoff, K. W. and Medcof, J. W. (2007). Performance in Internationally Dispersed Research and Development Teams. *Journal of High Technology Management,* Vol. 18, pp. 99-110.

Brown, J. S. and Duguid, P. (1991). Organizational Learning and Communities-of-Practice: Toward a Unified View of Working, Learning, and Innovation. *Organization Science,* Vol. 2, No. 1, pp. 40-57.

Buckley, P J. and Casson, M. C. (1998). Models of the Multinational Enterprise. *Journal of International Business Studies,* Vol. 29, No. 1, pp. 21-44.

Buckley, P. J. and Carter, M. J. (2004). A Formal Analysis of Knowledge Combination in Multinational Enterprises. *Journal of International Business Studies*, Vol. 35, pp. 371-384.

Burns, T. and Stalker, G. M. (1961). *The Management of Innovation*. Oxford, UK: Oxford University Press.

Cantwell, J. A., Dunning, J. H., and Janne, O. E. M. (2004). Towards a Technology Seeking Explanation of U.S. Direct Investment in the United Kingdom. *Journal of International Management,* Vol. 10, No. 1, pp. 5–20.

Cantwell, J. and Santangelo, G. D. (1999). The Frontier of International Technology Networks: Sourcing Abroad the Most Highly Tacit Capabilities. *Information Economics and Policy,* Vol. 11, pp. 101-123.

Cantwell, J. and Piscitello, L. (1999). The Emergence of Corporate International Networks for the Accumulation of Dispersed Technological Competences. *Management International Review,* Vol. 39, Special Issue 1999/1,pp. 123-147.

Cantwell, J. (1989). *Technological Innovation and Multinational Corporation*. Cambridge, MA, USA: Blackwell Publishing.

Cantwell, J. and Janne, O. (1999). Technological Globalization and Innovative Centres: The Role of Corporate Technological Leadership and Locational Hierarchy. *Research Policy,* Vol. 28, No. 2-3, pp. 119-114.

Cantwell, J. and Narula, R. (2001). The Eclectic Paradigm in the Global Economy. *International Journal of the Economics of Business,* Vol. 8, No. 2, pp. 155-172.

Cantwell, J. and Mudambi, R. (2005). MNE Competence-Creating Subsidiary Mandates. *Strategic Management Journal,* Vol. 26, pp. 1109-1128.

Cantwell, J. (1995). The Globalization of Technology: What Remains of the Product Cycle Model? *Cambridge Journal of Technology,* Vol. 19, pp. 155-174.

Cantwell, J. (1999). From the Early Internationalization of Corporate Technology to Global Technology Sourcing. *Transnational Corporations,* Vol. 8, No. 2, pp. 70-92.

Cardinal, L. B. (2001). Technological Innovation in the Pharmaceutical Industry: The Use of Organizational Control in Managing Research and Development. *Organization Science,* Vol. 12, No. 1, pp. 19-36.

Carmel, E. and Tjia, P. (2005). *Offshoring Information Technology.* Cambridge, UK: Cambridge University Press.

Cassiman, B. and Veugelers, R. (2006). In Search of Complementarity in Innovation Strategy: Internal R&D and External Knowledge Acquisition. *Management Science,* Vol. 52, No. 1, pp. 68-82.

Casson, M. and Singh, S. (1993). Corporate Research and Development Strategies: The Influence of Firm, Industry, and Country Factors on the Decentralization of R&D. *R&D Management,* Vol. 23, No. 2, pp. 91-107.

Cesaroni, F. (2004). Technological Outsourcing and Product Diversification: Do Markets for Technology Affect Firm's Strategies? *Research Policy,* Vol. 33, pp. 1547-1564.

Chakravarthy, B. (1997). A New Strategy Framework for Coping with Turbulence. *Sloan Management Review,* Vol. 38, No. 2, pp. 69–82.

Cheng, J. L. C. and Bolon, D. S. (1993). The Management of Multinational R&D: A Neglected Topic in International Business Research. *Journal of International Business Studies,* Vol. 24, No. 1, pp. 1-18.

Chesbrough, H. W. and Teece, D. J. (1996). When is Virtual Virtuous? *Harvard Business Review,* January-February, pp. 65-73.

Chiesa, V., Manzini, R., and Pizzurno, E. (2004). The Externalization of R&D Activities and the Growing Market of Product Development Services. *R&D Management,* Vol. 34, No. 1, pp. 65-75.

Chiesa, V. and Manzini, R. (1998). Organizing for Technological Collaboration: A Managerial Perspective. *R&D Management,* Vol. 28, No. 3, pp. 199-212.

Chiesa, V. (1996). Strategies for Global R&D. *Research Technology Management,* Sep-Oct, pp. 19-25.

Chiesa, V. (2000). Global R&D Project Management and Organization: A Taxonomy. *Journal of Product Innovation Management,* Vol. 17, pp. 341-359.

Chiesa, V. (1996). Managing the Internationalization of R&D Activities. *IEEE Transactions on Engineering Management,* Vol. 43, No. 1, pp. 7-23.

Child, J. (2003). Organizational Learning. In: D. O. Faulkner and A. Campbell (eds.), *The Oxford Handbook of Strategy,* New York, USA: Oxford University Press, pp. 443–471.

Child, J. (1973). Predicting and Understanding Organization Structure. *Administrative Science Quarterly,* Vol. 17, pp. 168-185.

Cohen, W. M. and Levinthal, D. A. (1989). Innovation and Learning: The Two Faces of R&D. *The Economic Journal,* Vol. 99, September, pp. 569-596.

Cohen, W. M. and Levinthal, D. A. (1990). Absorptive Capacity: A New Perspective on Learning and Innovation. *Administrative Science Quarterly,* Vol. 35, pp. 128-152.

Cohen, S. D. (2007). *Multinational Corporations and Foreign Direct Investment: Avoiding Simplicity, Embracing Complexity.* New York: Oxford University Press.

Collis, D. J. (1994). Research Note: How Valuable Are Organizational Capabilities? *Strategic Management Journal,* Vol. 15 (Winter Special Issue), pp. 143-152.

Conner, K. R. and Prahalad, C. K. (1996). A Resource–based Theory of the Firm: Knowledge Versus Opportunism. *Organization Science,* Vol. 7, No. 5, pp. 477–501.

Cray, D. (1984). Control and Coordination in Multinational Corporations. *Journal of International Business Issue,* Vol. 15, No. 2, pp. 85-98.

Creswell, J. W. (2003). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches.* Thousand Oaks, CA, USA: Sage Publications (Second Edition).

Cyert, R. M. and March, J. G. (1992). *A Behavioral Theory of the Firm*. Oxford, UK: Blackwell Publishing (Second Edition).

Damanpour, F. (1991). Organizational Innovation: A Meta-Analysis of Effects of Determinants and Moderators. *Academy of Management Journal,* Vol. 34, No. 3, pp. 555-590.

Damanpour, F. (1996). Organizational Complexity and Innovation: Developing and Testing Multiple Contingency Models. *Management Science,* Vol. 42, No. 5, pp. 693–716.

De Meyer, A. and Mizushima, A. (1989). Global R&D Management. *R&D Management,* Vol. 19, No. 2, pp. 135–146.

De Meyer, A. (1991). Tech Talk: How Managers Are Stimulating Global R&D Communication. *Sloan Management Review,* Spring, pp. 49-58.

De Meyer, A. (1993a). Internationalizing R&D Improves a Firm's Technical Learning. *Sloan Management Review*, Vol. 36, pp. 42–50.

De Meyer, A. (1993b). Management of an International Network of Industrial R&D Laboratories. *R&D Management*, Vol. 23, No. 2, pp. 109–120.

Dehoff, K. and Sehgal, V. (2006). Innovators Without Borders. *Strategy + Business,* Issue 44, pp. 1–8.

Denzin, N. and Lincoln, Y. (1998). *Strategies of Qualitative Inquiry.* Thousand Oaks, CA, USA: Sage Publications.

Dierickx, I. and Cool, K. (1989). Asset Stock Accumulation and Sustainability of Competitive Advantage. *Organization Science,* Vol. 35, No. 12, pp. 1504–1511.

Dirks, K. T. and Ferrin, D. L. (2001). The Role of Trust in Organizational Setting. *Organization Science,* Vol. 12, No. 4, pp. 450-467.

Dobson, P. J. (1999). Approaches to Theory Use in Interpretive Case Studies – A Critical Realist Perspective. *Proceedings of the 10th Australian Conference on Information Systems,* pp. 259–270.

Domberger, S. (1998). *The Contracting Organization: A Strategic Guide to Outsourcing*. Oxford, UK: Oxford University Press.

Dosi, G. and Marengo, L. (1994). Some Elements of an Evolutionary Theory of Organizational Competences. In: *Evolutionary Concepts in Contemporary Economics*, R. W. England (Ed.) University of Michigan Press, 1994, pp. 157-78.

Dosi, G. and Marengo, L. (2007). On the Evolutionary and Behavioral Theories of Organizations: A Tentative Roadmap. *Organization Science,* Vol. 18, No. 3, pp. 491–502.

Dougherty, D. (1992). Interpretive Barriers to Successful Product Innovation in Large Firms. *Organization Science,* Vol. 3, No. 2, pp. 179–202.

Downey, C., Greenberg, D., and Kapur, V. (2003). Reorienting R&D for a Horizontal Future. *Research • Technology Management,* September – October, pp. 22–28.

Downs, G. W. and Mohr, L. B. (1976). Conceptual Issues in the Study of Innovation. *Administrative Science Quarterly,* Vol. 21, pp. 700-714.

Doz, Y. and Prahalad, C. K. (1984). Patterns of Strategic Control within Multinational Corporations. *Journal of International Business Studies,* Vol. 15, No. 2, pp. 55-72.

Doz, Y. L. and Prahalad, C. K. (1991). Managing DMNCs: A Search for a New Paradigm. *Strategic Management Journal,* Vol. 12, pp. 145-164.

Doz, Y., Santos, J. and Williamson, P. (2001). *From Global to Metanational: How Companies Win in the Knowledge Economy.* Boston, MA, USA: Harvard Business School Press.

Doz, Y., Wilson, K., Veldhoen, S., Goldbrunner, T., and Altman, G. (2006). Innovation: Is Global the Way Forward. *Booz | Allen | Hamilton and INSEAD,* 13 pages.

Duga, J. and Stutt, T. (2006). Global R&D Report 2007: Globalization Alters Traditional R&D Rules. *R&D Magazine*, www.rdmag.com, September, pp. 41–47.

Dutta, S., Narasimhan, O., and Rajiv, S. (2005). Conceptualizing and Measuring Capabilities: Methodology and Empirical Applications. *Strategic Management Journal*, Vol. 26, pp. 277-285.

Dyer, J. H. and Singh, H. (1998). The Relational View: Cooperative Strategy and Sources of Interorganizational Competitive Advantage. *Academy of Management Review,* Vol. 23, No. 4, pp. 660-679.

Dyer, J. H. (1997). Effective Interfirm Collaboration: How Firms Minimize Transaction Costs and Maximize Transaction Value. *Strategic Management Journal,* Vol. 18, No. 7, pp. 535-556.

Dyer, J. H. and Chu, W. (2003). The Role of Trustworthiness in Reducing Transactions Costs and Improving Performance: Empirical Evidence from the United States, Japan, and Korea. *Organization Science,* Vol. 14, No. 1, pp. 57-68.

Edstrom, A. and Galbraith, J. (1977). Transfer of Managers as a Coordination and Control Strategy in Multinational Organizations. *Administrative Science Quarterly,* Vol. 22, pp. 248-263.

Eisenhardt, K. M. and Schoonhoven, C. B. (1996). Resource-Based View of Strategic Alliance Formation: Strategic and Social Effects in Entrepreneurial Firms. *Organization Science,* Vol. 7, pp. 136-150.

Eisenhardt, K. M. and Santos, F. M. (2002). Knowledge–Based View: A New Theory of Strategy? In: A. Pettigrew, H. Thomas, and R. Whittington (Eds.), *Handbook of Strategy and Management.* London: Sage, pp. 139–164.

Eisenhardt, K. M. and Martin, J. A. (2000). Dynamic Capabilities: What Are They? *Strategic Management Journal,* Vol. 21, pp. 1105-1121.

Eisenhardt, K. M. and Graebner, M. E. (2007). Theory Building from Cases: Opportunities and Challenges. *Academy of Management Journal,* Vol. 50, No. 1, pp. 25–32.

Eisenhardt, K. M. (1989a). Agency Theory: An Assessment and Review. *Academy of Management Review,* Vol. 14, No. 1, pp. 57-74.

Eisenhardt, K. M. (1989b). Building Theories from Case Study Research. *Academy of Management Review,* Vol. 14, No. 4, pp. 532–550.

EIU (2003). CEO Agenda: Corporate Priorities for 2003. *Economic Intelligence Unit*, 42 Pages

EIU (2004a). Harnessing Innovation: R&D in a Global Growth Economy. *Economist Intelligence Unit,* Whitepaper, May, 21 pages.

EIU (2004b). Scattering the Seeds of Innovation: The Globalization of Research and Development. *Economist Intelligence Unit,* Whitepaper, September 29 pages.

Ende, J. V. D., Wijnberg, N., and Meijer, A. (2001). Public Policy and Innovative Capabilities: The Case of Philip's IT Activities. *Technology Analysis & Strategic Management,* Vol. 13, No. 3, pp. 389–405.

Engardio, P. (2004). Sourcing the Planet for Brainiacs. *BusinessWeek,* October 11, 75th Anniversary Special Issue on "The Innovation Economy," pp. 66–69.

Engardio, P. and Einhorn, B. (2005). Outsourcing Innovation. *BusinessWeek,* March 21, pp. 50–57.

Engardio, P. (2006a). The Future of Outsourcing: How Is It Transforming Whole Industries and Changing the Way We Work. *BusinessWeek,* January 30, pp. 50–58.

Engardio, P. (2006b). R&D Offshoring: Is It Working? *BusinessWeek Online*, May 10; http://www.businessweek.com/print/globalbiz/context/may2006/gb20060510_613772.htm

Ettlie, J. E. (2006). *Managing Innovation: New Technology, New Products, and New Services in a Global Economy.* Oxford, UK: Butterworth–Heinemann (Second Edition).

Evans, J. S. (1982). Strategic Flexibility in Business. *SRI International,* Menlo Park, CA, USA: Research Report 678, 24 pages.

Evans, J. S. (1991). Strategic Flexibility for High Technology Manoeuvres: A Conceptual Framework. *Journal of Management Studies,* Vol. 28, No. 1, pp. 69–89.

Fama, E. (1980). Agency Problem and the Theory of the Firm. *Journal of Political Economy,* Vol. 88, pp. 288-307.

Fey, C. F. and Birkinshaw, J. (2005). External Sources of Knowledge, Governance Mode, and R&D Performance. *Journal of Management,* Vol. 31, pp. 597-621.

Fiol, C. M. and Lyles, M. A. (1985). Organizational Learning. *Academy of Management Review,* Vol. 10, No. 4, pp. 803-813.

Fiol, C. M. (1996). Squeezing Harder Doesn't Always Work: Continuing the Search for Consistency in Innovation Research. *Academy of Management Review,* Vol. 21, No. 4, pp. 1012–1021.

Fischer, W. A. and Behrman, J. N. (1979). The Coordination of Foreign R&D Activities by Transnational Corporations. *Journal of International Business Studies,* Vol. 10, No. 3, pp. 28-34.

Florida, R. (1997). The Globalization of R&D: Results of a Survey of Foreign-Affiliated R&D Laboratories in the USA. *Research Policy,* Vol. 26, pp. 85-103.

Forsgren, M., Johanson, J., and Sharma, D. (2000). Development of MNC Centers of Excellence. In: U. Holm and T. Pedersen (Eds.), *The Emergence and Impact of*

MNC Centres of Excellence-A Subsidiary Perspective, London, U.K.: MacMillan, pp. 45-67.

Foss, N. J. and Pedersen, T. (2002). Transferring Knowledge in MNCs: The Role of Sources of Subsidiary Knowledge and Organizational Context. *Journal of International Management,* Vol. 8, pp. 49-67.

Franko, L. G. (1989). Global Corporate Competition: Who's Winning, Who's Losing, and the R&D Factor as One Reason Why. *Strategic Management Journal,* Vol.10, pp. 449-474.

Friedman, T. L. (2005). *The World is Flat: A Brief History of the Twenty-First Century*. USA, New York: Farrar, Straus and Giroux.

Frost, T. S., Birkinshaw, J. M., and Ensign, P. C. (2002). Centres of Excellence in Multinational Corporations. *Strategic Management Journal,* Vol. 23, pp. 997-1018.

Frost, T. S. and Zhou, C. (2005). R&D Co-Practice and 'Reverse' Knowledge Integration in Multinational Firms. *Journal of International Business Studies,* Vol. 36, pp. 676-687.

Frost, T. S. (2001). The Geographic Sources of Foreign Subsidiaries' Innovations. *Strategic Management Journal*, Vol. 22, pp. 101-123.

Furu, P. (2001). Drivers of Competence Development in Different Types of Multinational R&D Subsidiaries. *Scandinavian Journal of Management,* Vol. 17, pp. 133-149.

Galbraith, J. R. (1973). *Designing Complex Organization.* USA, Reading, MA: Addison-Wesley.

Galunic, D. C. and Eisenhardt, K. M. (2001). Architectural Innovation and Modular Corporate Forms. *Academy of Management Journal,* Vol. 44, No. 6, pp. 1229–1249.

Ganguly, A. (1999). *Business–Driven Research and Development: Managing Knowledge to Create Wealth*. London, UK: MacMillan Business.

Garcia–Morales, V. J., Ruiz–Moreno, A., and Llorens–Montes, F. J. (2007). Effects of Technology Absorptive Capacity and Technology Proactivity on Organizational Learning, Innovation and Performance: An Empirical Examination. *Technology Analysis & Strategic Management,* Vol. 19, No. 4, pp. 527–558.

Gassmann, O. and von Zedtwitz, M. (1998). Organization of Industrial R&D on a Global Scale. *Research Policy,* Vol. 28, No. 3, pp. 147-161.

Gassmann, O. and von Zedtwitz, M. (1999). New Concepts and Trends in International R&D Organization. *Research Policy,* Vol. 28, No. 2-3, pp. 231-250.

Genus, A. (1995). Walls and Bridges: Towards a Multi–disciplinary Approach to the Concept of Flexibility. *Technology Analysis & Strategic Management,* Vol. 7, No. 3, pp. 287–306.

Gerybadze, A. and Reger, G. (1998). Managing Globally Distributed Competence Centres within Multinational Corporations: A Resource-Based View. *Research in International Business and International Relations,* Vol. 7, pp. 183-217.

Gerybadze, A. and Reger, G. (1999). Globalization of R&D: Recent Changes in the Management of Innovation in Transnational Corporations. *Research Policy,* Vol. 28, No. 2-3, pp. 251-274.

Ghoshal, S. and Bartlett, C. A. (1988). Creation, Adoption, and Diffusion of Innovations by Subsidiaries of Multinational Corporations. *Journal of International Business Studies,* Vol. 19, No. 3, pp. 365-388.

Ghoshal, S. and Bartlett, C. A. (1990). The Multinational Corporation as an Interorganizational Network. *Academy of Management Review,* Vol. 15, No. 4, pp. 603-625.

Ghoshal, S. (2005). Bad Management Theories Are Destroying Good Management Practices. *Academy of Management Learning & Education,* Vol. 4, No. 1, pp. 75–91.

Gilley, K. M. and Rasheed, A. (2000). Making More by Doing Less: An Analysis of Outsourcing and Its Effects on Firm Performance. *Journal of Management,* Vol. 26, No. 4, pp. 763-790.

Gillham, B. (2000). *The Research Interview.* London, UK: Continuum.

Gioia, D. A. and Pitre, E. (1990). Multiparadigm Perspectives on Theory Building. *Academy of Management Review,* Vol. 15, No. 4, pp. 584–602.

Goldstein, H. (2002). They Might Be Giants. *IEEE Spectrum,* September, Special R&D Report, pp. 43–48.

Gopalakrishnan, S. (2000). Unraveling the Links between Dimensions of Innovation and Organizational Performance. *The Journal of High Technology Management Research,* Vol. 11, No. 1, pp. 137–153.

Govindarajan, V. and Gupta, A.K. (2001). *The Quest for Global Dominance: Transforming Global Presence into Global Competitive Advantage.* San Francisco, CA, USA: Jossey–Bass.

Grant, R. M. (1991). The Resource–Based Theory of Competitive Advantage: Implications for Strategy Formulation. *California Management Review,* Spring, pp. 114–135.

Grant, R. M. (1996a). Toward a Knowledge–Based Theory of the Firm. *Strategic Management Journal,* Vol. 17, pp. 109–122.

Grant, R. M. (1996b). Prospering in Dynamically Competitive Environments: Organizational Capability as Knowledge Integration. *Organization Science,* Vol. 7, No. 4, pp, 375-387.

Grevesen, C. W. and Damanpour, F. (2007). Performance Implications of Organizational Structure and Knowledge Sharing in Multinational R&D Networks. *International Journal of Technology Management*, Vol. 38, No.1/2, pp. 113-136.

Grewal, R. and Tansuhaj, P. (2001). Building Organizational Capabilities for Managing Economic Crisis: The Role of Market Orientation and Strategic Flexibility. *Journal of Marketing,* Vol. 65, pp. 67–80.

Gupta, A. K. and Wilemon, D. (1996). Changing Patterns in Industrial R&D Management. *Journal of Product Innovation Management*, Vol. 13, pp. 497–511.

Gupta, A. K., Smith, K. G., and Shalley, C. E. (2006). The Interplay between Exploration and Exploitation. *Academy of Management Journal,* Vol. 49, No. 4, pp. 693–706.

Gupta, A. K., Tesluk, P., and Taylor, M. S. (2007). Innovation At and Across Multiple Levels of Analysis. *Organization Science,* Vol. 18, No. 6, pp. 885–897.

Gupta, A. K. and Govindarajan, V. (1991). Knowledge Flows and the Structure of Control within Multinational Corporations. *Academy of Management Journal,* Vol. 16, No. 4, pp. 768-792.

Gupta, A. K. and Govindarajan, V. (1994). Organizing for Knowledge Flows within MNCs. *International Business Review,* Vol. 3, No. 4, pp. 443-457.

Gupta, A. K. and Govindarajan, V. (2000). Knowledge Flows within Multinational Corporations. *Strategic Management Journal,* Vol. 21, pp. 473-496.

Hagedoorn, J. and Duysters, G. (2002). External Sources of Innovative Capabilities: The Preference for Strategic Alliances or Mergers and Acquisitions. *Journal of Management Studies,* Vol. 39, No. 2, pp. 167-188.

Hagedoorn, J. and Narula, R. (1996). Choosing Organizational Modes of Strategic Technology Partnering: International and Sectoral Differences. *Journal of International Business Studies,* Vol. 27, No. 2, pp. 265-284.

Hagedoorn, J. (2002). Inter-firm R&D Partnerships-An Overview of Patterns and Trends Since 1960. *Research Policy,* Vol. 31, pp. 477-492.

Hagel, J. III and Brown, J. S. (2005). *The Only Sustainable Edge: Why Business Strategy Depends on Productive Friction and Dynamic Specialization.* Boston, MA, USA: Harvard Business School Press.

Hakanson, L. and Nobel, R. (1993a). Determinants of Foreign R&D in Swedish Multinationals. *Research Policies,* Vol. 22, pp. 397-411.

Hakanson, L. and Nobel, R. (1993b). Foreign Research and Development in Swedish Multinationals. *Research Policies,* Vol. 22, pp. 373-396.

Hamel, G. (1991). Competition for Competence and Inter-partner Learning Within International Strategic Alliances. *Strategic Management Journal,* Vol. 12, pp. 83-104.

Hansen, M. and Lovas, B. (2004). How Do Multinational Companies Leverage Technological Competencies? Moving from Single to Interdependent Explanations. *Strategic Management Journal*, Vol. 25, No. 8-9, pp. 801-822.

Hansen, M. T. (2002). Knowledge Networks: Explaining Effective Knowledge Sharing in Multiunit Companies. *Organization Science,* Vol. 13, No. 3, pp. 232-248.

Hedlund, G. (1984). Organization In-Between: The Evolution of the Mother-Daughter Structure of Managing Foreign Subsidiaries in Swedish MNCs. *Journal of International Business Studies,* Vol. 15, No. 2, pp. 109-123.

Hedlund, G. (1986). The Hypermodern MNC – A Heterarchy? *Human Resource Management*, Vol. 25, No. 1, pp. 9-35.

Henderson, R. and Cockburn, I. (1994). Measuring Competence? Exploring Firm Effects in Pharmaceutical Research. *Strategic Management Journal,* Vol. 15, pp. 63–84.

Henderson, R. M. and Clark, K. B. (1990). Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms. *Administrative Science Quarterly,* Vol. 35, pp. 9-30.

Hipp, C. and Gassmann, O. (1999). Leveraged Knowledge Creation: The Role of Technical Services as External Success of Knowledge. *Proceedings of the Portland International Conference on Management of Engineering and Technology (PICMET)*, Vol. II, pp. 186-192.

Hitt, M. A., Keats, B. W., DeMarie, S. M. (1998). Navigating in the New Competitive Landscape: Building Strategic Flexibility and Competitive Advantage in the 21st Century. *Academy of Management Executive,* Vol. 12, No. 4, pp. 22–42.

Hodgson, G. M. (1998). Evolutionary and Competence-Based Theories of the Firm. *Journal of Economic Studies,* Vol. 25, No. 1, pp. 25-56.

Holm, U. and Pedersen, T. (Eds.) (2000). *The Emergence and Impact of MNC Centres of Excellence-A Subsidiary Perspective*. London, U.K.: MacMillan.

Hoskisson, R. E., Hitt, M. A., Wan, W. P., and Yiu, D. (1999). Theory and Research in Strategic Management: Swings of a Pendulum. *Journal of Management,* Vol. 25, No. 3, pp. 417-456.

Howells, J. (1999b). Research and Technology Outsourcing. *Technology Analysis and Strategic Management*, Vol. 11, No. 1, pp. 17-29.

Howells, J. (2000). International Coordination of Technology Flows and Knowledge Activity in Innovation. *International Journal of Technology Management,* Vol. 19, Nos. 7/8, pp. 806-819.

Howells, J. (1999a). Research and Technology Outsourcing and Innovation Systems: An Exploratory Analysis. *Industry and Innovation*, Vol. 6, No. 1, pp. 111-129.

Huber, G. P. (1991). Organizational Learning: The Contributing Processes and the Literatures. *Organization Science,* Vol. 2, No. 1, pp. 88-115.

Huchzermeier, A. and Loch, C. H. (1999). Project Management Under Risk: Using the Real Options Approach to Evaluate Flexibility in R&D. *INSEAD R&D,* Working Paper No. 99/15/TM, France: Fontainebleau.

Hurley, R. F. and Hult, T. M. (1998). Innovation, Market Orientation, and Organizational Learning: An Integration and Empirical Examination. *Journal of Marketing,* Vol. 62, July, pp. 42–54.

Ingham, M. and Mothe, C. (1998). How to Learn in R&D Partnerships? *R&D Management,* Vol. 28, No. 4, pp. 249-261.

Inkpen, A. and Ramaswamy, K. (2006). *Global Strategy: Creating and Sustaining Advantages Across Borders.* New York, USA: Oxford University Press.

Jaffee, D. (2004). Globalization, Offshoring, and Economic Convergence: A Synthesis. Presented at the Conference *Understanding Global Outsourcing,* Stern School of Business, New York University, 10 December, 33 pages.

Jansen, J. J. P., Van Den Bosch, F. A. J., and Volberda, H. W. (2006). Exploratory Innovation, Exploitative Innovation, and Performance: Effects of Organizational Antecedents and Environmental Moderators. *Management Science,* Vol. 52, No. 11, pp. 1661-1674.

Jaruzelski, B., Dehoff, K. and Bordia, R. (2005). Money Isn't Everything. *Strategy + Business*, Resilience Report, May 12, The Boston Consulting Group, Boston, MA, USA.

Jensen, J. L. and Rodgers, R. (2001). Cumulating the Intellectual Gold of Case Study Research. *Public Administration Review,* Vol. 61, No. 2, pp. 235–246.

Jensen, M. and Meckling, W. (1976). Theory of the Firm: Managerial Behavior, Agency Costs, and Ownership Structure. *Journal of Financial Economics,* Vol. 3, pp. 305-360.

Jonash, R. S. (1996). Strategic Technology Leveraging: Making Outsourcing Work for You. *Research Technology Management,* March-April, pp. 19-25.

Karlsson, M. (Ed.) (2006). The Internationalization of Corporate R&D: Leveraging the Changing Geography of Innovation. *ITPS – Swedish Institute for Growth Policy Studies,* Report Number A2006: 007.

Kessler, E. H. and Chakrabarti, A. K. (1996). Innovation Speed: A Conceptual Model of Context, Antecedents, and Outcomes. *Academy of Management Review,* Vol. 21, No. 4, pp. 1143–1191.

Kessler, E. H., Bierly, P. E., and Gopalakrishnan, S. (2000). Internal Vs. External Learning in New Product Development: Effects on Speed, Costs and Competitive Advantage. *R&D Management,* Vol. 30, No. 3, pp. 213-223.

Khurana, A. (2006). Strategies for Global R&D. *Research Technology Management,* Mar-Apr, pp. 48-57.

Kim, H., Park, J.-H., and Prescott, J. E. (2003). The Global Integration of Business Functions: A Study of Multinational Businesses in Integrated Global Industries. *Journal of International Business Studies,* Vol. 34, pp. 327-344.

Kim, W. C. and Mauborgne, R. (1991). Implementing Global Strategies: The Role of Procedural Justice. *Strategic Management Journal,* Vol. 12, pp. 125-143.

Kim, W. C. and Mauborgne, R. (1993). Procedural Justice, Attitudes, and Subsidiary Top Management Compliance with Multinationals' Corporate Strategic Decisions. *Academy of Management Journal,* Vol. 36, No. 3, pp. 502-526.

Kim, W. C. and Mauborgne, R. (1995). A Procedural Justice Model of Strategic Decision Making: Strategy Content Implications in the Multinational. *Organization Science,* Vol. 6, No. 1, pp. 44-61.

Kim, W. C. and Mauborgne, R. (1996). Procedural Justice and Managers' In-Role and Extra-Role Behavior: The Case of the Multinational. *Management Science*, Vol. 42, No. 4, pp. 499-515.

Kim, W. C. and Mauborgne, R. (1998). Procedural Justice, Strategic Decision Making, and the Knowledge Economy. *Strategic Management Journal,* Vol. 19, pp. 323-338.

Klein, H. K. and Myers, M. D. (1999). A Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems. *MIS Quarterly,* Vol. 23, No. 1, pp. 67–94.

Kogut, B. and Zander, U. (1992). Knowledge of the Firm, Combinative Capabilities, and the Replication of Technology. *Organization Science,* Vol. 3, No. 3, pp. 383–397.

Kogut, B. and Zander, U. (1993). Knowledge of the Firm and the Evolutionary Theory of the Multinational Corporation. *Journal of International Business Studies*, Vol. 24, No. 4, pp. 625-645.

Korine, H. and Gomez, P.–Y. (2002). *The Leap to Globalization: Creating New Value from Business Without Borders*. San Francisco, CA, USA: Jossey–Bass.

Kostova, T. and Roth, K. (2003). Social Capital in Multinational Corporations and a Micro-Macro Model of Its Formation. *Academy of Management Review,* Vol. 28, No. 2, pp. 297-317.

Kotabe, M., Dunlap-Hinkler, D., Parente, R. and Mishra, H. A. (2007). Determinants of Cross-National Knowledge Transfer and Its Effect on Firm Innovation. *Journal of International Business Studies,* Vol. 38, pp. 259-282.

Kotabe, M. (1998). Efficiency Vs. Effectiveness Orientation of Global Sourcing Strategy: A Comparison of U.S. and Japanese Multinational Companies. *Academy of Management Executive,* Vol. 12, No. 4, pp. 107-119.

Kuemmerle, W. (1997). Building R&D Capabilities Abroad. *Harvard Business Review,* Mar-Apr, pp.61-70.

Kuemmerle, W. (1999). The Drivers of Foreign Direct Investment into Research and Development: An Empirical Investigation. *Journal of International Business Studies,* Vol. 30, No. 1, pp. 1-24.

Lall, S. (1992). Technological Capabilities and Industrialization. *World Development*, Vol. 20, No. 2, pp. 165-186.

Lam, A. (2005). Organizational Innovation. In: J. Fagerberg, D. C. Mowery, and R. R. Nelson (Eds.), *The Oxford Handbook of Innovation,* New York, USA: Oxford University Press, pp. 115–147.

Langley, A. (1999). Strategies for Theorizing from Process Data. *Academy of Management Review,* Vol. 24, No. 4, pp. 691–710.

Lapadat, J. C. and Lindsay, A. C. (1999). Transcription in Research and Practice: From Standardization of Techniques to Interpretive Positioning. *Qualitative Inquiry,* Vol. 5, No. 1, pp. 64–86.

Lapadat, J. C. (2000). Problematizing Transcription: Purpose, Paradigm, and Quality. *International Journal of Social Research Methodology,* Vol. 3, No. 3, pp. 203–219.

Lawrence, P. and Lorsch, J. (1967). *Organization and Environment: Managing Differentiation and Integration*. USA, Boston, MA: Harvard University.

Lawrence, B. S. (1984). Historical Perspective: Using the Past to Study the Present. *Academy of Management Review,* Vol. 9, No. 2, pp. 307–312.

Lawson, B. and Samson, D. (2001). Developing Innovation Capability in Organizations: A Dynamic Capabilities Approach. *International Journal of Innovation Management,* Vol. 5, No. 3, pp. 377–400.

Le Bas, C. and Sierra, C. (2002). 'Location Versus Home Country Advantages' in R&D Activities: Some Further Results on Multinationals' Location Strategies. *Research Policy,* Vol. 31, pp. 589-609.

Lee, A. S. and Baskerville, R. L. (2003). Generalizing Generalizability in Information Systems Research. *Information Systems Research,* Vol. 14, No. 3, pp. 221–243.

Leeuw, A. C. J. De and Volberda, H. W. (1996). On the Concept of Flexibility: A Dual Control Perspective. *Omega – The International Journal of Management Science,* Vol. 24, No. 2, pp. 121–139.

Lengnick–Hall, C. A. (1992). Innovation and Competitive Advantage: What We Know and What We Need to Learn. *Journal of Management,* Vol. 18, No. 2, pp. 399–429.

Leonard, D. (1995). *Wellsprings of Knowledge: Building and Sustaining the Sources of Innovation.* Boston, MA, USA: Harvard Business School Press.

Leonard-Barton, D. (1992). Core Capabilities and Core Rigidities: A Paradox in Managing New Product Development. *Strategic Management Journal,* Vol. 13, pp. 111-125.

Leonard–Barton, D. (1990). A Dual Methodology for Case Studies: Synergistic Use of a Longitudinal Single Site with Replicated Multiple Realities. *Organization Science,* Vol. 1, No. 3, pp. 248–266.

Lepak, D. P., Smith, K. G., and Taylor, M. S. (2007). Value Creation and Value Capture: A Multilevel Perspective. *Academy of Management Review,* Vol. 32, No. 1, pp. 180-194.

Lewin, A. Y. and Peeters, C. (2006). The Top–Line Allure of Offshoring. *Harvard Business Review*, March, pp. 22 and 24.

Lewin, A. Y. and Volberda, H. W. (1999). Prolegomena on Coevolution: A Framework for Research on Strategy and New Organizational Forms. *Organization Science,* Vol. 10, No. 5, pp. 519–534.

Lewin, A. Y., Long, C. P. and Carroll, T. N. (1999). The Coevolution of New Organizational Forms. *Organization Science,* Vol. 10, No. 5, pp. 535–550.

Liebeskind, J. P., Oliver, A. L., Zucker, L., and Brewer, M. (1996). Social Networks, Learning, and Flexibility: Sourcing Scientific Knowledge in New Biotechnology Firms. *Organization Science,* Vol. 7, No. 4, pp. 428-443.

Lincoln, Y. S. and Guba, E. G. (1985). *Naturalistic Inquiry*. Newbury Park, CA, USA: Sage Publications.

Liu, M.-C. and Chen, S.-H. (2003). International R&D Deployment and Locational Advantages of Developing Countries: A Case Study of Taiwan. *NBER Working Paper,* Handle 10169, 28 pages.

Lorenzoni, G. and Lipparini, A. (1999). The Leveraging of Interfirm Relationships as a Distinctive Organizational Capability: A Longitudinal Study. *Strategic Management Journal,* Vol. 20, pp. 317-338.

MacCormack, A. and Iansiti, M. (1997). Product Development Flexibility. *Harvard Business School*, Working Paper 97–072.

Madhok, A. and Osegowitsch, T. (2000). The International Biotechnology Industry: A Dynamic Capabilities Perspective. *Journal of International Business Studies*, Vol. 31, No. 2, pp. 325-335.

Mahoney, J. T. and Sanchez, R. (2004). Building New Management Theory by Integrating Processes and Products of Thought. *Journal of Management Inquiry,* Vol. 13, No. 1, pp. 34–47.

March, J. G. (1991). Exploration and Exploitation in Organizational Learning. *Organization Science,* Vol. 2, No. 1, pp. 71-87.

Markus, M. L. and Robey, D. (1988). Information Technology and Organizational Change: Causal Structure in Theory and Research. *Management Science,* Vol. 34, No. 5, pp. 583–598.

Martinez, J. I. and Jarillo, J. C. (1989). The Evolution of Research on Coordination Mechanisms in Multinational Corporations. *Journal of International Business Studies,* Vol. 20, No. 3, pp. 489-514.

Martinez, J. I. and Jarillo, J. C. (1991). Coordination Demands of International Strategies. *Journal of International Business Studies*, Vol. 22, No. 3, pp. 429-444.

Maskell, P., Pedersen, T., Petersen, P. and Dick-Nielsen, J. (2007). Learning Paths to Offshore Outsourcing: From Cost Reduction to Knowledge Seeking. *Industry & Innovation,* Vol. 14, No. 3, pp. 239-257.

Mason, J. (2002). *Qualitative Researching.* London, UK: Sage Publications (Second Edition).

Matheson, D. and Matheson, J. (1998). *The Smart Organization: Creating Value through Strategic R&D.* Boston, MA, USA: Harvard Business School.

Maxwell, J. A. (1996). *Qualitative Research Design: An Interactive Approach.* Thousand Oaks, CA, USA: Sage Publications.

Mayer, R. C., Davis, J. H., and Schoorman, F. D. (1995). An Integrative Model of Organization Trust. *Academy of Management Review,* Vol. 20, No. 3, pp. 709-734.

McGrath, R. G. (2001). Exploratory Learning, Innovative Capacity, and Managerial Oversight. *Academy of Management Journal,* Vol. 44, No. 1, pp. 118–131.

McGrath, J. E. (1982). Dilemmatics: The Study of Research Choices and Dilemmas. In: *Judgment Calls in Research*, J. E. McGrath, J. Martin, and R. A. Kulka (Eds.), Beverly Hills, CA: Sage, pp. 69–102.

Medcof, J. W. (2000). The Resource–Based View and Transnational Technology Strategy. *The Journal of High Technology Management Research,* Vol. 11, No. 1, pp. 59–74.

Medcof, J. W. (1997). A Taxonomy of Internationally Dispersed Technology Units and Its Application to Management Issues. *R&D Management,* Vol. 27, No. 4, pp. 301-318.

Miles, M. B. and Huberman, A. M. (1994). *Qualitative Data Analysis: An Expanded Sourcebook.* Thousand Oaks, CA, USA: Sage Publications (Second Edition).

Miller, W. L. and Morris, L. (1999). *Fourth Generation R&D: Managing Knowledge, Technology, and Innovation.* New York, USA: John Wiley & Sons.

Mills, C. W. (2000). *The Sociological Imagination.* New York, USA: Oxford University Press (Fortieth Anniversary Edition).

Mintzberg, H. (1979). An Emerging Strategy of “Direct” Research. *Administrative Science Quarterly,* Vol. 24, pp. 582–589.

Mir, R. and Watson, A. (2000). Strategic Management and the Philosophy of Science: The Case for a Constructivist Methodology. *Strategic Management Journal,* Vol. 21, pp. 941–953.

Mohr, L. B. (1969). Determinants of Innovation in Organizations. *American Political Science Review,* Vol. 63, pp. 111-136.

Mol, M. J. (2005). Does Being R&D Intensive Still Discourage Outsourcing? Evidence from Dutch Manufacturing. *Research Policy,* Vol. 34, No. 4, pp. 571-582.

Mowery, D. C., Oxley, J. E., and Silverman, B. S. (1996). Strategic Alliances and Inter-firm Knowledge Transfer. *Strategic Management Journal,* Vol. 17, Winter Special Issue, pp. 77-91.

Mudambi, R., Mudambi, S. M., and Navarra, P. (2007). Global Innovation in MNCs: The Effects of Subsidiary Self-Determination and Teamwork. *Journal of Product Innovation Management,* Vol. 24, pp. 442-455.

Mudambi, R. (2007). Offshoring: Economic Geography and Multinational Firm. *Journal of International Business Studies,* Vol. 38, Issue 1, pp. 206–210.

Murray, J. Y. (2001). Strategic Alliance-Based Global Sourcing Strategy for Competitive Advantage: A Conceptual Framework and Research Propositions. *Journal of International Marketing,* Vol. 9, No. 4, pp. 30-58.

Myers, M. B. and Rosenbloom, R. S. (1996). Rethinking the Role of Research. *Research • Technology Management,* May–June, pp. 14–18.

Nahapiet, J. and Ghoshal, S. (1998). Social Capital, Intellectual Capital, and the Organizational Advantage. *Academy of Management Review,* Vol. 23, No. 2, pp. 242-266.

Narula, R. and Hagedoorn, J. (1999). Innovating through Strategic Alliances: Moving Towards International Partnerships and Contractual Agreements. *Technovation,* Vol. 19, pp. 283-294.

Narula, R. (2001). "Choosing Between Internal and Non-Internal R&D Activities: Some Technological and Economic Factors." *Technology Analysis & Strategic Management*, Vol. 13, No. 3, pp. 365-387.

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

Nickerson, J. A. and Zenger, T. R. (2004). A Knowledge–Based Theory of the Firm-The Problem–Solving Perspective. *Organization Science,* Vol. 15, No. 6, pp. 617–632.

Niosi, J. (1999). The Internationalization of Industrial R&D: From Technology Transfer to the Learning Organization. *Research Policy,* Vol. 28, No. 2-3, pp. 107-117.

Nishiguchi, T. (1994). *Strategic Industrial Sourcing: The Japanese Advantage.* New York, USA: Oxford University Press.

Nobel, R. and Birkinshaw, J. (1998). Innovation in Multinational Corporations: Control and Communication Patterns in International R&D Operations. *Strategic Management Journal,* Vol. 19, pp. 479-496.

Nohria, N. and Gulati, R. (1996). Is Slack Good or Bad for Innovation? *Academy of Management Journal,* Vol. 39, No. 5, pp. 1245–1264.

Nohria, N. and Ghoshal, S. (1994). Differentiated Fit and Shared Values: Alternatives for Managing Headquarters-Subsidiary Relations. *Strategic Management Journal,* Vol. 15, pp. 491-502.

Nohria, N. and Ghoshal, S. (1997). *The Differentiated Network: Organizing Multinational Corporations for Value Creation.* San Francisco, CA, USA: Jossey–Bass.

Nonaka, I. and Takeuchi, H. (1995). *The Knowledge Creating Company: How Japanese Companies Create the Dynamics of Innovation.* New York, USA: Oxford University Press.

Nonaka, I. (1994). A Dynamic Theory of Organizational Knowledge Creation. *Organization Science,* Vol. 5, No. 1, pp. 14–37.

OECD (2002). Frascati Manual: Proposed Standard Practice for Surveys on Research and Experimental Development. *Organization for Economic Cooperation and Development*, Paris, France (Sixth Edition).

OECD (2006). Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data. *Organization for Economic Cooperation and Development*, Paris, France and Eurostat (Third Edition).

Ohmae, K. (2005). *The Next Global Stage: Challenges and Opportunities in Our Borderless World.* Delhi, India: The Wharton School Publishing (First Indian Reprint).

Ohmae, K. (1994). *The Borderless World: Power and Strategy in the Global Marketplace*. London, UK: HarperCollins Publishers (Paperback Edition).

Oliver, D. G., Serovich, J. M., and Mason, T. L. (2005). Constraints and Opportunities with Interview Transcription: Towards Reflection in Qualitative Research. *Social Forces,* Vol. 84, No. 2, pp. 1273–1289.

Orlikowski, W. J. and Baroudi, J. J. (1991). Studying Information Technology in Organizations: Research Approaches and Assumptions. *Information Systems Research,* Vol. 2, No. 1, pp. 1–28.

Pearce, R. and Papanastassiou, M. (1996). R&D Networks and Innovation: Decentralized Product Development in Multinational Enterprises. *R&D Management,* Vol. 26, No. 4, pp. 315-333.

Pearce, R. D. (1999). Decentralized R&D and Strategic Competitiveness: Globalized Approaches to Generation and Use of Technology in Multinational Enterprises (MNEs). *Research Policy,* Vol. 28, No. 2-3, pp. 157-178.

Penner-Hahn, J. D. (1998). Firm and Environmental Influences on the Mode and Sequence of Foreign Research and Development Activities. *Strategic Management Journal,* Vol. 19, No. 1, pp. 149-168.

Penrose, E. (1995). *The Theory of the Growth of the Firm.* New York, USA: Oxford University Press (Third Edition).

Pentland, B. T. (1999). Building Process Theory with Narrative: From Description to Explanation. *Academy of Management Review,* Vol. 24, No. 4, pp. 711–724.

Persaud, A. and Kumar, U., and Kumar, V. (2002). Coordination Structures and Innovative Performance in Global R&D Labs. *Canadian Journal of Administrative Science,* Vol. 19, No. 1, pp. 57-75.

Persaud, A. (2005). Enhancing Synergestic Innovative Capability in Multinational Corporations: An Empirical Investigation. *Journal of Product Innovation Management,* Vol. 22, p. 412-429.

Peteraf, M. A. (1993). The Cornerstones of Competitive Advantage: A Resource–Based View. *Strategic Management Journal,* Vol. 14, pp. 179–191.

Pettigrew, A. M. (1990). Longitudinal Field Research on Change: Theory and Practice. *Organization Science,* Vol. 1, No. 3, pp. 267–292.

Phillips, F. and Tuladhar, S. D. (2000). Measuring Organizational Flexibility: An Exploration and General Model. *Technological Forecasting and Social Change,* Vo. 64, pp. 23–38.

Pierce, J. L. and Delbecq, A. L. (1977). Organization Structure, Individual Attitudes and Innovation. *Academy of Management Review,* January, pp. 27–37.

Pisano, G.P. (1990). The R&D Boundaries of the Firm: An Empirical Analysis. *Administrative Science Quarterly*, Vol. 35, March, pp. 153-176.

Piscitello, L. and Rabbiosi, L. (2004). The Impact of MNCs' Foreign Activities on the Innovative Performance of the Parent Companies. Presented at the *DRUID Summer*

Conference 2004 on Industrial Dynamics, Innovation and Development, Elsinore, Denmark, June 14-16.

Poole, M. S. and Van de Ven, A. H. (1989). Using Paradox to Build Management and Organization Theories. *Academy of Management Review,* Vol. 14, No. 4, pp. 562–578.

Powell, W. W., Koput, K. W., and Smith-Doerr, L. (1996). Interorganizational Collaboration and the Locus of Innovation: Networks of Learning in Biotechnology. *Administrative Science Quarterly,* Vol. 41, pp. 116-145.

Prahalad, C. K. and Hamel, G. (1990). The Core Competence of the Corporation. *Harvard Business Review,* Vol. 68, May–June, pp. 79–91.

Prasad, A. and Prasad, P. (2002). The Coming Age of Interpretive Organizational Research. *Organization Research Methods,* Vol. 5, No. 1, pp. 4–11.

Priem, R. L. and Butler, J. E. (2001a). Is the Resource-Based View a Useful Perspective for Strategic Management Research? *Academy of Management Review*, Vol. 26, No. 1, pp. 22-40.

Priem, R. L. and Butler, J. E. (2001b). Tautology in the Resource-Based View and the Implications of Externally Determined Resource Value: Further Comments. *Academy of Management Review,* Vol. 26, No. 1, pp. 57-66.

Quelin, B. and Duhamel, F. (2003). Bringing Together Strategic Outsourcing and Corporate Strategy: Outsourcing Motives and Risks. *European Management Journal,* Vol. 21, No. 5, pp. 647-661.

Quinn, J. B., Baruch, J. J., and Zien, K. A. (1997). *Innovation Explosion: Using Intellect and Software to Revolutionize Growth Strategies.* New York, USA: The Free Press.

Quinn, J. B. and Hilmer, F. G. (1994). Strategic Outsourcing. *Sloan Management Review,* Summer Issue, pp. 43-55.

Quinn, J. B. (1999). Strategic Outsourcing: Leveraging Knowledge Capabilities. *Sloan Management Review,* Summer Issue, pp. 9-21.

Ravichandran, T. (2000). Redefining Organization Innovation: Towards Theoretical Advancement. *The Journal of High Technology Management Research,* Vol. 10, No. 2, pp. 243-274.

Reger, G. (1997). Benchmarking the Internationalization and Co-ordination of R&D of Western European and Japanese Multi-national Corporations. *International Journal of Innovation Management,* Vol. 1, No. 3, pp. 299-331.

Reger, G. (2004). Coordinating Globally Dispersed Research Centres of Excellence-The Case of Philips Electronics. *Journal of International Management,* Vol. 10, No. 1, pp. 51–76.

Reger, G. (1999). Internationalization and Coordination of Research and Development a Large Corporations. *Management International,* Vol. 3, No.2, pp. 13-32.

Rindova, V. P. and Kotha, S. (2001). Continuous "Morphing": Competing through Dynamic Capabilities, Form, and Function. *Academy of Management Journal,* Vol. 44, No. 6, pp. 1263–1280.

Roberts, E. (2001). Benchmarking Global Strategic Management of Technology. *Research • Technology Management*, March–April, pp. 25–36.

Robson, C. (2002). *Real World Research.* Oxford, UK: Blackwell Publishing (Second Edition).

Roethlisberger, F. J. (1977). *The Elusive Phenomena.* Boston, MA, USA: Harvard University Press.

Rogers, E. M. (1995). *Diffusion of Innovations*. New York, USA: The Free Press (Fourth Edition).

Ronstadt, R. C. (1978). International R&D: The Establishment and Evolution of Research and Development Abroad by Seven U. S. Multinationals. *Journal of International Business Studies,* Vol. 9, No. 1, pp. 7-24.

Ross, S. (1973). The Economic Theory of Agency: The Principal's Problem. *American Economic Review*, Vol. 63, pp. 134-139.

Roush, W. (2001). Lean Mean R&D Machines. *Technology Review,* December, pp. 71–73.

Roussel, P. A., Saad, K. N., and Erickson, T. J. (1991). *Third Generation R&D: Managing the Link to Corporate Strategy*. Boston, MA, USA: Harvard Business School.

Ryan, P., Giblin, M., and Walshe, E. (2004). From Subcontracted R&D to Joint Collaboration: The Role of Trust in Facilitating This Process. *International Journal of Innovation and Technology Management,* Vol. 1, No. 2, pp. 205–231.

Sampson, R. C. (2007). R&D Alliances & Firm Performance: The Impact of Technological Diversity and Alliance Organization on Innovation. *Academy of Management Journal*, Vol. 50, No. 2, pp. 364-386.

Sanchez, R. and Mahoney, J.T. (1996). Modularity, Flexibility, and Knowledge Management in Product and Organization Design. *Strategic Management Journal,* Vol. 17, pp. 63–76.

Sanchez, R. (1995). Strategic Flexibility in Product Competition. *Strategic Management Journal,* Vol. 16, pp. 135–159.

Sanchez, R. (1997). Preparing for an Uncertain Future: Managing Organizations for Strategic Flexibility. *International Studies of Management and Organization,* Vol. 27, No. 2, pp. 71–94.

Sandberg, J. (2005).How Do We Justify Knowledge Produced Within Interpretive Approaches? *Organizational Research Methods,* Vol. 8, No. 1, pp. 41–68.

Santiago, L. P. and Vakili, P. (2005). On the Value of Flexibility in R&D Projects. *Management Science,* Vol. 51, No. 8, pp. 1206–1218.

Schilling, M. A. and Steensma, H. K. (2001). The Use of Modular Organizational Forms: An Industry–Level Analysis. *Academy of Management Journal,* Vol. 44, No. 6, pp. 1149–1168.

Schoonhoven, C. B., Eisenhardt, K. M., and Lyman, K. (1990). Speeding Products to Markets: Wanting Time to First Product Introduction in New Firms. *Administrative Science Quarterly,* Vol. 35, pp. 177-207.

Schumpeter, J. A. (1983). *The Theory of Economic Development*. New Brunswick, NJ, USA: Transaction Publishers.

Shenton, A. K. (2004). Strategies for Ensuring Trustworthiness in Qualitative Research Projects. *Education for Information,* Vol. 22, pp. 63–75.

Shimizu, K. and Hitt, M. A. (2004). Strategic Flexibility: Organizational Preparedness to Reverse Ineffective Strategic Decisions. *Academy of Management Executive,* Vol. 18, No. 4, pp. 44–59.

Silverman, D. (2000). *Doing Qualitative Research: A Practical Handbook*. London, UK: Sage Publications.

Singh, J. (2008). Distributed R&D, Cross Regional Knowledge Integration and Quality of Innovative Output. *Research Policy,* Vol. 37, No. 1, pp. 77-96.

Singh, J. (2007). Asymmetry of Knowledge Spillovers between MNCs and Host Country Firms. *Journal of International Business Studies*, Vol. 38, No. 5, pp. 764-786.

Sirmon, D. G., Hitt, M. A., and Ireland, R. D. (2007). Managing Firm Resources in Dynamic Environments to Create Value: Looking Inside the Black Box. *Academy of Management Review,* Vol. 32, No. 1, pp. 273-292.

Smith, A. D. and Zeithaml, C. (1996). Garbage Cans and Advancing Hypercompetition: The Creation and Exploitation of New Capabilities and Strategic Flexibility in Two Regional Bell Operating Companies. *Organization Science,* Vol. 7, No. 4, pp. July–August, pp. 388–399.

Song, J. and Shin, J. (2008). The Paradox of Technological Capabilities: A Study of Knowledge Sourcing from Host Countries of Overseas R&D Operations. *Journal of International Business Studies*, Vol. 39, No. 2, pp. 291-303.

Spender, J. –C. (1996). Making Knowledge the Basis of a Dynamic Theory of the Firm. *Strategic Management Journal,* Vol. 17, pp. 45–62.

Stake, R. E. (1995). *The Art of Case Study Research*. Thousand Oaks, CA, USA: Sage Publications.

Stake, R. E. (2006). *Multiple Case Study Analysis*. New York, USA: The Guilford Press.

Steensma, H. K. and Corley, K. G. (2000). On the Performance of Technology-Sourcing Partnerships: The Interaction Between Partner Interdependence and Technology Attributes. *Academy of Management Journal,* Vol. 43, No. 6, pp. 1045-1067.

Strauss, A. and Corbin, J. (1998). *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory.* Thousand Oaks, CA, USA: Sage Publications (Second Edition).

Sturges, J. E. and Hanrahan, K. J. (2004). Comparing Telephone and Face–to–Face Qualitative Interviewing: A Research Note. *Qualitative Research,* Vol. 4, No. 1, pp. 107–188.

Suarez, F. F., Cusumano, M. A. and Fine, C. H. (1991). Flexibility and Performance: A Literature Critique and Strategic Framework. *Sloan School of Management,* MIT Working Paper #3298–91–BPS.

Subramaniam, M. and Youndt, M. A. (2005). The Influence of Intellectual Capital on the Types of Innovative Capabilities. *Academy of Management Journal,* Vol. 48, No. 3, pp. 450–463.

Subramaniam, M. and Venkataraman, N. (2001). Determinants of Transnational New Product Development Capability: Testing the Influence of Transferring and Deploying Tacit Overseas Knowledge. *Strategic Management Journal,* Vol. 22, pp. 359-378.

Subramaniam, M., Rosenthal, S. R., and Hatten, K. J. (1998). Global New Product Development Processes: Preliminary Findings and Research Propositions. *Journal of Management Studies,* Vol. 35, No. 6, pp. 773-796.

Suddaby, R. (2006). From the Editors: What Grounded Theory is Not? Academy of Management Journal, Vol. 49, No. 4, pp. 633–642.

Sutton, R. I. (1997). The Virtues of Closet Qualitative Research. *Organization Science,* Vol. 8, No. 1, pp. 97–106.

Szulanski, G. (1996). Exploring Internal Stickiness: Impediments to the Transfer of Best Practices Within the Firm. *Strategic Management Journal,* Vol. 17, pp. 27-53.

Taggart, J. H. (1997). Autonomy and Procedural Justice: A Framework for Evaluating Subsidiary Strategy. *Journal of International Business Studies,* Vol. 28, No. 1, pp. 51-76.

Teece, D. J. (1986). Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy. *Research Policy,* Vol. 15, No. 6, pp. 285-305.

Teece, D. J. and Pisano, G. (1994). The Dynamic Capabilities of Firms: An Introduction. *Industrial and Corporate Change,* Vol. 3, No. 3, pp. 537-556.

Teece, D. J. (1998). Capturing Value from Knowledge Assets: The New Economy, Markets for Know–How, and Intangible Assets. *California Management Review,* Vol. 40, No. 3, pp. 55–78.

Teece, D. J., Pisano, G., and Shuen, A. (1997). Dynamic Capabilities and Strategic Management. *Strategic Management Journal,* Vol. 18, No. 7, pp. 509-533.

Teigland, R., Fey, C. F., and Birkinshaw, J. (2000). Knowledge Dissemination in Global R&D Operations: Am Empirical Study of Multinationals in the High

Technology Electronics Industry. *Management International Review,* Vol. 40, Special Issue 2000/1, pp. 49-77.

Tessler, S. and Barr, A. (1997). Software R&D Strategies of Developing Countries. *Stanford Computer Industry Project Paper,* Stanford University.

Thomke, S. and Reinertsen, D. (1998). Agile Product Development: Managing Development Flexibility in Uncertain Environments. *California Management Review,* Vol. 41, No. 1, pp. 8–30.

Thomke, S. H. (1997). The Role of Flexibility in the Development of New Products: An Empirical Study. *Research Policy,* Vol. 26, pp. 105–119.

Trochim, W. M. K. (2001). *The Research Methods Knowledge Base.* Cincinnati, OH, USA: Atomic Dog Publishing (Second Edition).

Tsai, W. and Ghoshal, S. (1998). Social Capital and Value Creation: The Role of Intrafirm Networks. *Academy of Management Journal,* Vol. 41, No. 4, pp. 464-476.

Tsai, W. (2001). Knowledge Transfer in Intraorganizational Networks: Effects of Network Position and Absorptive Capacity on Business Unit Innovation and Performance. *Academy of Management Journal,* Vol. 44, No. 5, pp. 996-1004.

Tsoukas, H. (1996). The Firm as a Distributed Knowledge System: A Constructionist Approach. *Strategic Management Journal,* Vol. 17, pp. 11–25.

Tushman, M. L. and O'Reilly III, C. A. (1996). The Ambidextrous Organization: Managing Evolutionary and Revolutionary Change. *California Management Review,* Vol. 38, No.4, Summer, pp. 1–23.

Tushman, M. L. and Anderson, P. (1986). Technological Discontinuities and Organizational Environments. *Administrative Science Quarterly,* Vol. 31, No. 3, pp. 439-465.

Tushman, M. L. (1979). Managing Communication Networks in R&D Laboratories. *Sloan Management Review,* Winter, pp. 37-49.

Tyler, B. B. (2001). The Complementarity of Cooperative and Technological Competencies: A Resource–Based Perspective. *Journal of Engineering and Technology Management,* Vol. 18, pp. 1–27.

Un, C. A. and Cuervo–Cazurra, A. (2004). Strategies for Knowledge Creation. *British Journal of Management,* Vol. 15, pp. S27–S41.

Un, C. A. (2002). Innovative Capability Development in U.S. and Japanese Firms. *Academy of Management Proceedings,* pp. IM: E1–E6.

UNCTAD (2004a). The Impact of FDI on Development: Globalization of R&D by Transnational Corporations and Implications for Developing Countries. *United Nations Conference on Trade and Development,* Report No. TD/B/COM.2/EM.16/2, December 7, 16 pages.

UNCTAD (2004b). World Investment Report (Theme: The Shift Towards Services). *United Nations Conference on Trade and Development,* The United Nations, Geneva and New York.

UNCTAD (2005). World Investment Report (Theme: Transnational Corporation and the Internalization of R&D). *United Nations Conference on Trade and Development,* The United Nations, Geneva and New York.

Van De Ven, A. H. and Huber, G. P. (1990). Longitudinal Field Research Methods for Studying Processes of Organizational Change. *Organization Science,* Vol. 1, No. 3, pp. 213–219.

Van den Ven, A. H. and Poole, M. S. (1990). Methods for Studying Innovation Development in the Minnesota Innovation Research Program. *Organization Science,* Vol. 1, No. 3, pp. 313–335.

Venaik, S., Midgley, D. F., and Devinney, T. M. (2005). Dual Paths to Performance: The Impact of Global Pressures on MNC Subsidiary Conduct and Performance. *Journal of International Business Studies,* Vol. 36, pp. 655-675.

Verdu–Jover, A. J., Llorens–Montes, J. F. and Garcia–Morales, V. J. (2005). Flexibility, Fit and Innovative Capacity: An Empirical Examination. *International Journal of Technology Management,* Vol. 30, Nos. 1&2, pp. 131–146.

Vernon, R. E. (1979). The Product Cycle Hypothesis in a New International Environment. *Oxford Journal of Economics and Statistics,* Vol. 41, pp. 255–267.

Vernon, R. E. (1966). International Investment and International Trade in the Product Cycle. *Quarterly Journal of Economics,* Vol. 80, pp. 190–207.

Veugelers, R. and Cassiman, B. (1999). Make and Buy in Innovation Strategies: Evidence from Belgian Manufacturing Firms. *Research Policy,* Vol. 28, pp. 63-80.

Veugelers, R. (1997). Internal R&D Expenditures and External Technology Sourcing. *Research Policy,* Vol. 26, pp. 303-315.

Vining, A. and Globerman, S. (1999). A Conceptual Model for Understanding the Outsourcing Decision. *European Management Journal,* Vol. 17, No. 6, pp. 645-654.

Volberda, H. (1996). Toward the Flexible Form: How to Remain Vital in Hypercompetitive Environments. *Organization Science,* Vol. 7, No. 4, pp. 359–374.

Volberda, H. (1997). Building Flexible Organizations for Fast–Moving Markets. *Long Range Planning,* Vol. 30, No. 2, pp. 169–183.

Volberda, H. W. (1998). *Building the Flexible Firm.* New York, USA: Oxford University Press.

Volberda, H. W. (2003). Strategic Flexibility: Creating Dynamic Competitive Advantages. In: D. O. Faulkner and A. Campbell (Eds.), *The Oxford Handbook of Strategy,* New York, USA: Oxford University Press, pp. 939–998.

Von Hayek, F. A. (1989). The Pretence of Knowledge (Nobel Lecture). *American Economic Review,* December, pp. 3–7.

von Hippel, E. (1988). *The Source of Innovation*. U. K., Oxford: Oxford University Press.

von Zedtwitz, M., Gassmann, O., and Boutellier, R. (2004). Organizing Global R&D: Challenges and Dilemmas. *Journal of International Management,* Vol. 10, No. 1, pp. 21–49.

von Zedtwitz, M. and Gassmann, O. (2001). Market Versus Technology Drive in R&D Internationalization: Four Different Patterns of Managing Research and Development. *Research Policy,* Vol. 31, No. 4, pp. 569-588.

Walsham, G. (2006). Doing Interpretive Research. *European Journal of Information Systems,* Vol. 15, pp. 320–330.

Walsham, G. (1995). Interpretive Case Studies in IS Research: Nature and Method. *European Journal of Information Systems,* Vol. 4, No. 2, pp. 74–81.

Wang, C. L. and Ahmed, P. K. (2007). Dynamic Capabilities: A Review and Research Agenda. *International Journal of Management Reviews,* Vol. 9, No. 1, pp. 31-51.

Weber, R. (2004). The Rhetoric of Positivism Versus Interpretivism: A Personal View. *MIS Quarterly,* Vol. 28, No. 1, pp. iii–xii.

Weick, K. E. (1982). Management of Organizational Change Among Loosely Coupled Elements. In: P. S. Goodman and Associates (eds.), *Change in Organizations: New Perspectives in Theory, Research, and Practice,* San Francisco, CA, USA: Jossey–Bass, pp. 375–408.

Weick, K. E. (1989). Theory Construction as Disciplined Imagination. *Academy of Management Review,* Vol. 14, No. 4, pp. 516–531.

Wernerfelt, B. (1984). A Resource–based View of the Firm. *Strategic Management Journal,* Vol. 5, pp. 171–180.

Westney, D. E. (2001). Multinational Enterprises and Cross-Border Knowledge Creation. In: *Knowledge Emergence: Social, Technical and Evolutionary Dimensions of Knowledge Creation*, Nonaka, I. and Toshihiro, T. (Eds.), Chapter 9, Oxford, UK: Oxford University Press, pp. 147-75.

Williams, M. (2001). The Status of Generalization in Interpretive Research. In: *Qualitative Research: An International Guide to Issues in Practice,* May, T. (ed.), London, UK: Sage Publications.

Williams, M. (2000). Interpretivism and Generalization. *Sociology,* Vol. 34, No. 2, pp. 209–224.

Williamson, O. E. (1985). *The Economic Institutions of Capitalism.* New York, USA: The Free Press.

Winter, S. G. (2003). Understanding Dynamic Capabilities. *Strategic Management Journal,* Vol. 24, pp. 991-995.

Wolfe, R. A. (1994). Organizational Innovation: Review, Critique and Suggested Research Directions. *Journal of Management Studies,* Vol. 31, No. 3, pp. 405-431.

Yin, R. K. (2003a). *Applications of Case Study Research.* Thousand Oaks, CA, USA: Sage Publications (Second Edition).

Yin, R. K. (2003b). *Case Study Research: Design and Methods.* Thousand Oaks, CA, USA: Sage Publications (Third Edition).

Yip, G. S. (1992). *Total Global Strategy: Managing for Worldwide Competitive Advantage*. Englewood Cliffs, NJ: Prentice Hall.

Zander, U. and Kogut, B. (1995). Knowledge and the Speed of the Transfer and Imitation of Organizational Capabilities: An Empirical Test. *Organization Science,* Vol. 6, No. 1, pp. 76–92.

Zander, I. and Solvell, O. (2000). Cross-Border Innovation in the Multinational Corporation. *International Studies of Management and Organization,* Vol. 30, No. 2, pp. 44-67.

Zander, I. (1999). How Do You Mean 'Global'? An Empirical Investigation of Innovation Networks in the Multinational Corporation. *Research Policy,* Vol. 28, No. 2-3, pp. 195-213.

Zhao, Y. and Calantone, R. J. (2003). The Trend Toward Outsourcing in New Product Development: Case Studies in Six Firms. *International Journal of Innovation Management,* Vol. 7, No. 1, pp. 51-66.

Zollo, M. and Winter, S. G. (2002). Deliberate Learning and the Evolution of Dynamic Capabilities. *Organization Science,* Vol. 13, No. 3, pp. 339-351.

Appendix I: Guidelines for Software R&D

The guidelines provided by Frascati Manual (OECD, 2002) suggest that software development is to be treated as R&D if it leads to an advance in the area of computer software or anything that results in an increase in the stock of knowledge. According to the Frascati Manual, for software development projects to be classified as R&D its completion must be dependent on a scientific and/or technological advance and the aim of the project must be systematic resolution of a scientific and/or technological uncertainty. The manual considers use of software for a new application or purpose by itself an advance. A scientific and/or technological advance in software may be achieved even if a project is not completed, because a failure can increase knowledge of the technology of computer software by showing, for example, that a particular approach will not succeed (OECD, 2002).

The following types of software development activities are classified as R&D in software (OECD, 2002):

- R&D producing new theorems and algorithms in the field of theoretical computer science
- Development of operating systems, programming languages, data management, communication software, and software development tools
- Research into methods of designing, developing, deploying or maintaining software
- Software development that produces advances in generic approaches for capturing, transmitting, storing, retrieving, manipulating, or displaying information.
- R&D on software tools or techniques in specialized areas, e.g., image processing, artificial intelligence, etc.

Software related activities of a routine nature that do not involve scientific or technological advance or resolution of technological uncertainties do not qualify as R&D. For example, application software development using known methods and existing tools, support for existing systems, and adaptation of existing software do not qualify as software R&D activities. (OECD, 2002).

APPENDIX II: INTERVIEW GUIDES

This research used two different interview guides—one for informants at firm headquarters and the other for informants at offshore R&D units. Not all the questions were posed to every informant. Also, the flow of questions during interviews varied from the sequence in which they are appended below. Most importantly, these questions only provided pointers and probes to the researcher; the exact framing and orientation of questions evolved during the course of conversations with informants.

<u>Interview Guide for Informants at Offshore R&D Organizations</u>

- Please tell me about your background, role, and responsibility. How long have you been with the organization?
- Please tell me about the current R&D program you are associated with. What are you working on? Who are you working with (overseas locations)?
- How is the R&D program organized? Who do you work/collaborate with? Who do you report to? Who manages the R&D program? Who makes the decisions related to the R&D program? What are the types of decisions made locally?
- How (on what basis) was the work/program allocated/assigned to your organization? What criteria are used for allocation of work to your organization in general?
- What are key goals and success factors for the R&D program/project? How would you describe the contributions of your organization for the success of the program?
- What in your view are the most significant contributions made by your organization to the parent firm? Why are they significant?
- What are some of the examples of innovations produced by your organization either in the current or in previous R&D programs? How did the innovations come about? What were the enablers? How did the innovations impact business performance?
- How do you measure your innovation contributions?
- How is learning and knowledge shared and assimilated into the organization?
- How do you contribute to your parent organization's knowledge base? How do your counterparts at the parent firm headquarters learn from you?
- How does your organization contribute to the need for organizational flexibility of the parent company?
- How would you describe the relationship between your organization and the parent organization? How has this relationship developed over the years?

- What aspects of the relationship you find helpful for your ability to achieve higher performance and what aspects you would like to see changed? Why?
- How would you describe the value proposition of your organization to the parent company?

Interview Guide for Informants at Headquarters Organizations

- Please tell me about your role and responsibility in the organization.
- How have you been associated with the offshore R&D organization? In what capacity and how long?
- Why did you or your company choose to pursue captive/third-party offshoring of R&D?
- How do you engage the offshore R&D organization for your programs? How do you allocate R&D tasks to them? What kind of R&D tasks do you allocate to them, and why?
- How would you describe your approach to managing the offshore R&D organization?
- For the R&D program(s) you manage, what are the key success factors/criteria?
- How does the offshore R&D organization in India contribute to the success of your R&D programs and products? How does the offshore R&D organization contribute to the competitiveness of the company?
- How would you describe the value proposition of the offshore R&D organization to your organization/company?
- What in your view are some of the major contributions made by the offshore R&D organization?
- Can you provide examples of innovations produced by the offshore R&D organization? How did these innovations come about?
- How does the offshore R&D organization contribute to learning and development of knowledge of your organization and the firm as a whole?
- What is the role of flexibility in the competitiveness of your organization? What type of flexibility and why is that important?
- How does the offshore R&D organization contribute to your need for flexibility? What type of flexibility does the offshore R&D organization enable and what is the source of such flexibility? How do you leverage the flexibility offered by the offshore R&D organization?

APPENDIX III: SITUATING THE RESEARCHER IN THE STUDY

The phenomenon of offshoring of R&D has gained substantial momentum in the last few years, and has been extensively covered in the business press. However, as noted earlier, the academic literature on the subject is almost nonexistent. With increasing prominence of offshoring of R&D in the competitiveness of high technology firms, an understanding of effective organization and management of offshore R&D assumes vital importance. Ever since graduating from the engineering school in 1992, I have been working in the high tech industry and have had the chance to witness the phenomenon of R&D offshoring unfold and accelerate. I have also directly managed offshore R&D operations. So, in as much as the void in the extant literature has motivated me to undertake this research, my own background and interests have also greatly fueled my curiosity to systematically understand the phenomenon of offshoring of R&D and its strategic dimensions for firm competitiveness. In this backdrop, a description of my own background and experiences merits consideration not only for positioning the study in a proper context but also in the identification and handling of potential researcher biases (Robson, 2002).

Soon after completing my engineering education in 1992, I worked for the Indian Space Research Organization (ISRO) at its Space Applications Center in Ahmedabad in central India, where I engaged in carrying out research and development for space applications technology. At ISRO, I found some rudimentary R&D outsourcing arrangements and many formal R&D partnerships being employed as part of the overall space technology research and development programs. However, my direct exposure to offshore R&D began when in 1996 I moved to work with Siemens Communications Software (SCS) in Bangalore – a subsidiary of Siemens Public Communication Networks headquartered in Germany. This was the time when the phenomenon of offshoring was starting to gain prominence. Attracted by the low cost structures and the ability to access highly talented resource pool, many multinational companies had begun to leverage the benefits of R&D offshoring by either establishing their own R&D centers or by outsourcing R&D to companies in India.

SCS was mainly chartered to carry out software R&D for Siemens' public communications products, and I was responsible for R&D project and quality management across the Center. Specifically, my job at SCS was focused on helping projects improve their R&D performance and quality – aspects crucial for a new offshore R&D center to establish its credibility within the corporation. My stint with Siemens allowed me an opportunity to experience first-hand the issues and challenges involved in globalization of R&D by multinational companies. As a matter of fact, I was overwhelmed by the complexities involved in organizing and managing globally distributed R&D as I struggled hard to successfully deliver on my objectives amidst cultural and time zone differences, geographical separations, and diverse stakeholder expectations.

In 1997, I took up a new position as a member of the start-up management team that was responsible for setting up Lucent Technologies Software R&D Center in Bangalore. At that time, Lucent used to outsource some of its R&D work to three large Indian R&D services vendors, and intended to continue working with them while simultaneously growing its R&D capability at its own R&D center. So, as a general manager, I was not only responsible for establishing and growing Lucent's own offshore R&D center but also induction and oversight of R&D outsourcing partners under what a hybrid organizational model. It was really at Lucent that I received the full-blown exposure to the dynamics and complexities involved in the organization and management of offshore R&D. The challenge at hand was to establish a best-in-class offshore software R&D organization while successfully beating the barriers of time, distance and culture, and simultaneously balancing the various economic, technical, legal, and (inter) organizational considerations involved in offshore R&D work. In fact, there were times when the work I managed spanned seven countries and three continents!

However, it was apparent to me both from my previous experience at Siemens and the current situation at Lucent that the primary motivation for these companies to establish their offshore R&D presence was to benefit from cost arbitrage by exploiting the large-scale, low-cost resource pool. Yet, based on my observations of some of the projects within SCS and experiences of the other members of the start-up management team at Lucent, who had worked at the offshore R&D centers of some of the largest high technology companies, I came to believe that there could be more strategic benefits from offshore R&D than only structural cost savings. My belief was also strengthened by some of the initial success stories of offshore R&D in India that were doing rounds in the local industry and business press. Interestingly, all the four members of the founding team at Lucent's newly established R&D Center in Bangalore shared the collective vision that the India R&D organization won't limit itself to be just a 'cost center' like most of the multinational R&D subsidiaries operating in India. Instead, the team (including me) resolved that it would transform the center into a 'value' center, positioning it in the critical path of Lucent's global business performance over a period of four years.

As I along with the other start-up team members set out to develop the India R&D plan for Lucent Technologies India R&D center, we undertook an extensive benchmarking exercise to study the multinational company (MNC) subsidiaries in India to understand how they operated. This study culminated in the creation of a model we internally referred to as *Engineering Ownership Model*, which basically suggested that MNCs offshored R&D by adopting one of the two approaches: (a) offshore R&D center in India would bid for R&D work competing with the company's other R&D locations or (b) offshore R&D center in India would focus on specific competencies/areas and collaborate with other groups in the company in a complementary fashion. We found the first approach based on "bidding" to be rather tactical in nature and the second approach, which emphasized cultivation of competency ownership, to be strategic and beneficial in the long run. So, we crafted a strategy to organize Lucent's India R&D program by adopting a competency-based approach. As part of this strategic planning, we determined the competencies and technologies that Lucent's own R&D center would focus on and those that the various partners would be responsible for so as to develop an integrated competency-based approach for the hybrid India R&D organization model.

As we organized and operated R&D programs around a competency and technology-based approach, I found that not only structural cost savings accrued but also a potential for an enhanced level of innovation, learning and flexibility for Lucent was clearly indicated. I also came across instances where the R&D outsourcing partners contributed valuable innovation and learning. The model, complemented with a few management innovations, also resulted in greater employee involvement and retention in a business environment characterized by intense competition for talent. The dominant perception as well as practice associated with offshoring of R&D at that time considered it merely as a way to achieve cost reduction and as a result, offshoring was usually approached in a very tactical manner. My hands-on managerial experiences at Lucent, however, suggested that offshore R&D holds promise beyond just cost savings but in order to harness its full potential a systematic, strategic approach was needed.

Towards the end of 2002, when I moved to spearhead services innovation and R&D at Infosys Technologies – a large technology services company providing R&D and IT outsourcing services to clients globally – I found myself looking for ways in which offshore R&D outsourcing vendors can enhance their value proposition to their clients. Although my job context at Infosys had reversed (at Lucent I outsourced R&D to services vendors but now I was part of a company that performed outsourced R&D for high technology firms), my curiosity to understand how offshore R&D can confer strategic value that was actually sparked off at Lucent was further fueled at Infosys.

My experiences at Lucent and Infosys as well as some of the well-known offshore R&D success stories that surfaced (e.g., Texas Instruments' R&D Center in Bangalore) hinted that offshoring of R&D can be harnessed beyond structural savings to derive strategic gains in terms of innovation, learning and knowledge creation as well as organizational flexibility. Yet, given the central importance of innovation, learning and knowledge creation, and organizational flexibility to the competitiveness of high technology firms, it puzzled me frequently to find most companies viewing offshoring of R&D primarily as a platform for cost arbitrage. This is equally true in case of offshore R&D outsourcing, which is increasingly being accepted by several firms globally as part of their R&D and innovation strategy although most of them still appear to be looking at R&D outsourcing as a way of cutting costs. Whilst it is understandable that cost arbitrage helps companies address their profitability target as well as gives leeway in pricing structures, it was clear, though, that by restricting their expectations only to cost arbitrage these companies were not reaping the full potential of R&D offshoring. From a rudimentary comparative analysis, it appeared that what was preventing many of these companies from realizing the full potential of offshore R&D was a very tactical, ad-hoc approach to offshoring. In other words, it appeared that the difference lied in certain organizational and managerial practices but it would not be completely apparent as to what those were.

With the growing propensity towards offshoring of R&D, I found the pursuit of doctoral research to be most opportune to systematically examine the phenomenon and acquire a comprehensive understanding of how it could endow high technology firms with strategic advantages. Specifically, I wanted to go beyond my own limited experiences and perceptions to look at the phenomenon holistically and rigorously and construct a body of knowledge that could not only illuminate on the strategic aspects of offshoring of R&D but also inform managerial practice. While my own experience and interest have played a part in motivating this research, it should be clear, though, that I have only limited experience, in particular contexts, with the specific aspects of offshoring of R&D that have ignited my curiosity – those that form the core of this research. Thus, while I did not make the impractical attempt to 'offload' my background and experiences in carrying out the research, I was constantly conscious of the fact that to gain an understanding of the phenomenon – beyond the partial, contextual understanding that I might possess - would require me to be 'open' and 'observant' throughout the course of the research.

EXECUTIVE SUMMARY

Innovation and flexibility are central to the competitiveness of high technology firms. While innovation and knowledge creation form the primary fuel for continued firm growth in high technology industries, flexibility has emerged as a crucial requirement for effective competitive action. Research and development (R&D) is a major source of innovation for technology–based enterprises. Over the decades, the forms and practices of R&D management have evolved in tune with the changing competitive dynamics and the macro changes in the business environment. One noteworthy development is the emergence of offshoring of R&D, which can be interpreted as a new phenomenon as well as a new organizational form within the realm of globalization of R&D.

Offshoring is a relatively recent and still emerging phenomenon. Rooted in the notion of comparative advantage, offshoring of R&D involves disaggregation and global distribution of the firm's R&D value chain activities to leverage innovation capacity of low-cost countries. Characteristically different from market- and technology-seeking globalization of R&D, offshoring is motivated by the intertwining competitive needs to gain efficiency and access knowledge resources. Offshoring of R&D not only involves new international division of labor but also signifies shifting geographies of innovation Offshoring of R&D is fast gaining ground and is typically being hosted by developing countries that offer high quality but low cost technical talent pool. Offshoring of R&D can be intra-firm or inter-firm (outsourcing).

However, offshoring of R&D is generally viewed as a vehicle for cost reduction and hence is often approached rather tactically. An analysis of practice suggests that most firms usually do not or are not able to systematically harness the strategic potential of offshoring of R&D. With increasingly central role of offshoring of R&D in the competitiveness of high technology firms, it is critically important to go beyond structural cost savings and comprehend the strategic dimensions of the phenomenon. While the business press has keenly followed the emergence and unfolding of offshoring of R&D, the scholarly research on the subject is almost nonexistent. Therefore, the *raison d'être* of this research is simple: acquire comprehensive, grounds-up understanding of the phenomenon of offshoring of R&D and understand its influence on firm competitiveness. Specifically, going beyond structural cost savings, the research examines the link between offshoring of R&D and the firm's innovative capability and organizational flexibility—the two most important organizational capabilities of high technology firms.

This study pivots on three bodies of literature: R&D globalization and externalization, organizational innovation and flexibility, and dynamic capabilities perspective and agency theory. Employing an interpretive approach, the research includes 8 in-depth case studies of intra-firm and inter-firm offshoring of software R&D across a range of industries.

The research represents one of the first systematic attempts to develop a comprehensive understanding of the terrain of offshoring of R&D, and makes new contributions to both theory and managerial practice. Specifically, grounded in real-life instances of offshoring of R&D across industry sectors, the study illuminates on the link between offshoring of R&D and the firm's innovative capability and organizational flexibility. In addition, based on extensive empirical research, a definition of 'offshore R&D' is proposed with detailed characterization of the phenomenon. Moreover, the study also compares and contrasts intra-firm offshoring of R&D with inter-firm offshoring of R&D. In addition, the research presents a normative model of offshore R&D with a view to inform managerial practice and provide guidance to managers to strategically leverage offshoring of R&D.

The findings of the research indicate that by strategically organizing and managing offshoring of R&D, firms can significantly enhance their innovative capability and organizational flexibility. The results demonstrate that offshoring of R&D endows a firm with higher innovation volume and variety, improved innovation speed, and considerable innovation latitude. Further, the findings suggest that offshoring of R&D is a new global organizational form that not only serves as an adaptive device but also allows firms to achieve ambidexterity. The case studies show that offshoring of R&D has the potential to confer significant strategic, structural and operational flexibility to high technology firms. It appears that the combined benefits of innovative capability and organizational flexibility offers a flexible innovation capacity that allows high technology firms to pursue a strategic portfolio of options at low cost, leading to leverageable competitive advantage rooted in comparative advantage.

ABOUT THE AUTHOR

Deependra Moitra is currently an independent management consultant and has formerly held various technical and managerial positions at some of the most admired global corporations. Mr. Moitra has 16 years of multifaceted professional experience spanning business consulting and technology products as well as services sectors. Prior to becoming a management consultant, Mr. Moitra was the general manager for R&D at Infosys Technologies and the general manager for engineering at Lucent Technologies' India R&D Center. Earlier in his career, Mr. Moitra worked with Siemens Communications Software and the Indian Space Research Organization.

Mr. Moitra is a frequent speaker at major industry forums and international conferences, and serves on numerous advisory boards as well as journal editorial boards. He has several publications to his credit including the widely acclaimed book, *China and India: Opportunities and Threats for the Global Software Industry*, published in 2007 by Chandos Publishing (Oxford) Limited. Mr. Moitra received the B. Tech. degree in instrumentation and control engineering from the University of Calicut in 1992, where he graduated with honors at the top of his program. A recipient of numerous awards and honors, he is a member of the Academy of Management. Mr. Moitra resides in Bangalore, India and can be contacted by email at deependra@moitra.com or via www.moitra.com.

ERASMUS RESEARCH INSTITUTE OF MANAGEMENT (ERIM)

ERIM PH.D. SERIES

RESEARCH IN MANAGEMENT

ERIM Electronic Series Portal: http://hdl.handle.net/1765/1

Althuizen, N.A.P., *Analogical Reasoning as a Decision Support Principle for Weakly Structured Marketing Problems*, Promotor: Prof. dr. ir. B. Wierenga, EPS-2006-095-MKT, ISBN: 90-5892-129-8, http://hdl.handle.net/1765/8190

Alvarez, H.L., *Distributed Collaborative Learning Communities Enabled by Information Communication Technology*, Promotor: Prof. dr. K. Kumar, EPS-2006-080-LIS, ISBN: 90-5892-112-3, http://hdl.handle.net/1765/7830

Appelman, J.H., *Governance of Global Interorganizational Tourism Networks: Changing Forms of Co-ordination between the Travel Agency and Aviation Sector*, Promotors: Prof. dr. F.M. Go & Prof. dr. B. Nooteboom, EPS-2004-036-MKT, ISBN: 90-5892-060-7, http://hdl.handle.net/1765/1199

Assem, M.J. van den, *Deal or No Deal? Decision Making under Risk in a Large-Stake TV Game Show and Related Experiments*, PRomotor: Prof. dr. J. Spronk, EPS-2008-138-F&A, ISBN: 978-90-5892-173-4, http://hdl.handle.net/1765/1

Baquero, G, *On Hedge Fund Performance, Capital Flows and Investor Psychology*, Pomotor: Prof. dr. M.J.C.M. Verbeek, EPS-2006-094-F&A, ISBN: 90-5892-131-X, http://hdl.handle.net/1765/8192

Berens, G., *Corporate Branding: The Development of Corporate Associations and their Influence on Stakeholder Reactions*, Promotor: Prof. dr. C.B.M. van Riel, EPS-2004-039-ORG, ISBN: 90-5892-065-8, http://hdl.handle.net/1765/1273

Berghe, D.A.F. van den, *Working Across Borders: Multinational Enterprises and the Internationalization of Employment*, Promotors: Prof. dr. R.J.M. van Tulder & Prof. dr. E.J.J. Schenk, EPS-2003-029-ORG, ISBN: 90-5892-05-34, http://hdl.handle.net/1765/1041

Berghman, L.A., *Strategic Innovation Capacity: A Mixed Method Study on Deliberate Strategic Learning Mechanisms*, Promotor: Prof. dr. P. Mattyssens, EPS-2006-087-MKT, ISBN: 90-5892-120-4, http://hdl.handle.net/1765/7991

Bijman, W.J.J., *Essays on Agricultural Co-operatives: Governance Structure in Fruit and Vegetable Chains*, Promotor: Prof. dr. G.W.J. Hendrikse, EPS-2002-015-ORG, ISBN: 90-5892-024-0, http://hdl.handle.net/1765/867

Bispo, A., *Labour Market Segmentation: An investigation into the Dutch hospitality industry,* Promotors: Prof. dr. G.H.M. Evers & Prof. dr. A.R. Thurik, EPS-2007-108-ORG, ISBN: 90-5892-136-9, http://hdl.handle.net/1765/10283

Blindenbach-Driessen, F., *Innovation Management in Project-Based Firms*, Promotor: Prof. dr. S.L. van de Velde, EPS-2006-082-LIS, ISBN: 90-5892-110-7, http://hdl.handle.net/1765/7828

Boer, C.A., *Distributed Simulation in Industry,* Promotors: Prof. dr. A. de Bruin & Prof. dr. ir. A. Verbraeck, EPS-2005-065-LIS, ISBN: 90-5892-093-3, http://hdl.handle.net/1765/6925

Boer, N.I., *Knowledge Sharing within Organizations: A situated and Relational Perspective,* Promotor: Prof. dr. K. Kumar, EPS-2005-060-LIS, ISBN: 90-5892-086-0, http://hdl.handle.net/1765/6770

Boer-Sorbán, K., *Agent-Based Simulation of Financial Markets: A modular, Continuous-Time Approach,* Promotor: Prof. dr. A. de Bruin, EPS-2008-119-LIS, ISBN: 90-5892-155-0, http://hdl.handle.net/1765/10870

Boon, C.T., *HRM and Fit: Survival of the Fittest!?,* Promotors: Prof. dr. J. Paauwe & Prof. dr. D.N. den Hartog, EPS-2008-129-ORG, ISBN: 978-90-5892-162-8, http://hdl.handle.net/1765/1

Brito, M.P. de, *Managing Reverse Logistics or Reversing Logistics Management?* Promotors: Prof. dr. ir. R. Dekker & Prof. dr. M. B. M. de Koster, EPS-2004-035-LIS, ISBN: 90-5892-058-5, http://hdl.handle.net/1765/1132

Brohm, R., *Polycentric Order in Organizations: A Dialogue between Michael Polanyi and IT-Consultants on Knowledge, Morality, and Organization,* Promotors: Prof. dr. G. W. J. Hendrikse & Prof. dr. H. K. Letiche, EPS-2005-063-ORG, ISBN: 90-5892-095-X, http://hdl.handle.net/1765/6911

Brumme, W.-H., *Manufacturing Capability Switching in the High-Tech Electronics Technology Life Cycle,* Promotors: Prof. dr. ir. J.A.E.E. van Nunen & Prof. dr. ir. L.N. Van Wassenhove, EPS-2008-126-LIS, ISBN: 978-90-5892-150-5, http://hdl.handle.net/1765/1

Burgers, J.H., *Managing Corporate Venturing: Multilevel Studies on Project Autonomy, Integration, Knowledge Relatedness, and Phases in the New Business Development Process,* Promotors: Prof. dr. ir. F.A.J. Van den Bosch & Prof. dr. H.W. Volberda, EPS-2008-136-STR, ISBN: 978-90-5892-174-1, http://hdl.handle.net/1765/1

Campbell, R.A.J., *Rethinking Risk in International Financial Markets*, Promotor: Prof. dr. C.G. Koedijk, EPS-2001-005-F&A, ISBN: 90-5892-008-9, http://hdl.handle.net/1765/306

Chen, H., *Individual Mobile Communication Services and Tariffs*, Promotor: Prof. dr. L.F.J.M. Pau, EPS-2008-123-LIS, ISBN: 90-5892-158-1, http://hdl.handle.net/1765/11141

Chen, Y., *Labour Flexibility in China's Companies: An Empirical Study*, Promotors: Prof. dr. A. Buitendam & Prof. dr. B. Krug, EPS-2001-006-ORG, ISBN: 90-5892-012-7, http://hdl.handle.net/1765/307

Damen, F.J.A., *Taking the Lead: The Role of Affect in Leadership Effectiveness*, Promotor: Prof. dr. D.L. van Knippenberg, EPS-2007-107-ORG, http://hdl.handle.net/1765/10282

Daniševská, P., *Empirical Studies on Financial Intermediation and Corporate Policies*, Promotor: Prof. dr. C.G. Koedijk, EPS-2004-044-F&A, ISBN: 90-5892-070-4, http://hdl.handle.net/1765/1518

Delporte-Vermeiren, D.J.E., *Improving the Flexibility and Profitability of ICT-enabled Business Networks: An Assessment Method and Tool*, Promotors: Prof. mr. dr. P.H.M. Vervest & Prof. dr. ir. H.W.G.M. van Heck, EPS-2003-020-LIS, ISBN: 90-5892-040-2, http://hdl.handle.net/1765/359

Derwall, J.M.M., *The Economic Virtues of SRI and CSR*, Promotor: Prof. dr. C.G. Koedijk, EPS-2007-101-F&A, ISBN: 90-5892-132-8, http://hdl.handle.net/1765/8986

Dijksterhuis, M., *Organizational Dynamics of Cognition and Action in the Changing Dutch and US Banking Industries*, Promotors: Prof. dr. ir. F.A.J. van den Bosch & Prof. dr. H.W. Volberda, EPS-2003-026-STR, ISBN: 90-5892-048-8, http://hdl.handle.net/1765/1037

Elstak, M.N., *Flipping the Identity Coin: The Comparative Effect of Perceived, Projected and Desired Organizational Identity on Organizational Identification and Desired Behavior*, Promotor: Prof. dr. C.B.M. van Riel, EPS-2008-117-ORG, ISBN: 90-5892-148-2, http://hdl.handle.net/1765/10723

Erken, H.P.G., *Productivity, R&D and Entrepreneurship*, Promotor: Prof. dr. A.R. Thurik, EPS-2008-147-ORG, ISBN: 978-90-5892-179-6, http://hdl.handle.net/1765/1

Fenema, P.C. van, *Coordination and Control of Globally Distributed Software Projects*, Promotor: Prof. dr. K. Kumar, EPS-2002-019-LIS, ISBN: 90-5892-030-5, http://hdl.handle.net/1765/360

Fleischmann, M., *Quantitative Models for Reverse Logistics*, Promotors: Prof. dr. ir. J.A.E.E. van Nunen & Prof. dr. ir. R. Dekker, EPS-2000-002-LIS, ISBN: 35-4041-711-7, http://hdl.handle.net/1765/1044

Flier, B., *Strategic Renewal of European Financial Incumbents: Coevolution of Environmental Selection, Institutional Effects, and Managerial Intentionality*, Promotors: Prof. dr. ir. F.A.J. van den Bosch & Prof. dr. H.W. Volberda, EPS-2003-033-STR, ISBN: 90-5892-055-0, http://hdl.handle.net/1765/1071

Fok, D., *Advanced Econometric Marketing Models*, Promotor: Prof. dr. Ph.H.B.F. Franses, EPS-2003-027-MKT, ISBN: 90-5892-049-6, http://hdl.handle.net/1765/1035

Ganzaroli, A., *Creating Trust between Local and Global Systems*, Promotors: Prof. dr. K. Kumar & Prof. dr. R.M. Lee, EPS-2002-018-LIS, ISBN: 90-5892-031-3, http://hdl.handle.net/1765/361

Gilsing, V.A., *Exploration, Exploitation and Co-evolution in Innovation Networks*, Promotors: Prof. dr. B. Nooteboom & Prof. dr. J.P.M. Groenewegen, EPS-2003-032-ORG, ISBN: 90-5892-054-2, http://hdl.handle.net/1765/1040

Ginkel, W.P. van, *The Use of Distributed Information in Decision Making Groups: The Role of Shared Task Representations*, Promotor: Prof. dr. D. van Knippenberg, EPS-2007-097-ORG, http://hdl.handle.net/1765/8424

Govers, R., *Virtual Tourism Destination Image: Glocal Identities Constructed, Perceived and Experienced*, Promotors: Prof. dr. F.M. Go & Prof. dr. K. Kumar, EPS-2005-069-MKT, ISBN: 90-5892-107-7, http://hdl.handle.net/1765/6981

Graaf, G. de, *Tractable Morality: Customer Discourses of Bankers, Veterinarians and Charity Workers*, Promotors: Prof. dr. F. Leijnse & Prof. dr. T. van Willigenburg, EPS-2003-031-ORG, ISBN: 90-5892-051-8, http://hdl.handle.net/1765/1038

Groot, E.A. de, *Essays on Economic Cycles*, Promotors: Prof. dr. Ph.H.B.F. Franses & Prof. dr. H.R. Commandeur, EPS-2006-091-MKT, ISBN: 90-5892-123-9, http://hdl.handle.net/1765/8216

Gutkowska, A.B., *Essays on the Dynamic Portfolio Choice*, Promotor: Prof. dr. A.C.F. Vorst, EPS-2006-085-F&A, ISBN: 90-5892-118-2, http://hdl.handle.net/1765/7994

Hagemeijer, R.E., *The Unmasking of the Other*, Promotors: Prof. dr. S.J. Magala & Prof. dr. H.K. Letiche, EPS-2005-068-ORG, ISBN: 90-5892-097-6, http://hdl.handle.net/1765/6963

Halderen, M.D. van, *Organizational Identity Expressiveness and Perception Management: Principles for Expressing the Organizational Identity in Order to Manage the Perceptions and Behavioral Reactions of External Stakeholders*, Promotor: Prof. dr. S.B.M. van Riel, EPS-2008-122-ORG, ISBN: 90-5892-153-6, http://hdl.handle.net/1765/10872

Hartigh, E. den, *Increasing Returns and Firm Performance: An Empirical Study*, Promotor: Prof. dr. H.R. Commandeur, EPS-2005-067-STR, ISBN: 90-5892-098-4, http://hdl.handle.net/1765/6939

Hermans. J.M., *ICT in Information Services; Use and Deployment of the Dutch Securities Trade, 1860-1970,* Promotor: Prof. dr. drs. F.H.A. Janszen, EPS-2004-046-ORG, ISBN 90-5892-072-0, http://hdl.handle.net/1765/1793

Heugens, P.P.M.A.R., *Strategic Issues Management: Implications for Corporate Performance*, Promotors: Prof. dr. ir. F.A.J. van den Bosch & Prof. dr. C.B.M. van Riel, EPS-2001-007-STR, ISBN: 90-5892-009-7, http://hdl.handle.net/1765/358

Heuvel, W. van den, *The Economic Lot-Sizing Problem: New Results and Extensions*, Promotor: Prof. dr. A.P.L. Wagelmans, EPS-2006-093-LIS, ISBN: 90-5892-124-7, http://hdl.handle.net/1765/1805

Hoedemaekers, C.M.W., *Performance, Pinned down: A Lacanian Analysis of Subjectivity at Work*, Promotors: Prof. dr. S. Magala & Prof. dr. D.H. den Hartog, EPS-2008-121-ORG, ISBN: 90-5892-156-7, http://hdl.handle.net/1765/10871

Hooghiemstra, R., *The Construction of Reality: Cultural Differences in Self-serving Behaviour in Accounting Narratives*, Promotors: Prof. dr. L.G. van der Tas RA & Prof. dr. A.Th.H. Pruyn, EPS-2003-025-F&A, ISBN: 90-5892-047-X, http://hdl.handle.net/1765/871

Hu, Y., *Essays on the Governance of Agricultural Products: Cooperatives and Contract Farming*, Promotors: Prof. dr. G.W.J. Hendrkse & Prof. Dr. B. Krug, EPS-2007-113-ORG, ISBN: 90-5892-145-1, http://hdl.handle.net/1765/10535

Huij, J.J., *New Insights into Mutual Funds: Performance and Family Strategies*, Promotor: Prof. dr. M.C.J.M. Verbeek, EPS-2007-099-F&A, ISBN: 90-5892-134-4, http://hdl.handle.net/1765/9398

Huurman, C.I., *Dealing with Electricity Prices*, Promotor: Prof. dr. C.D. Koedijk, EPS-2007-098-F&A, ISBN: 90-5892-130-1, http://hdl.handle.net/1765/9399

Iastrebova, K, *Manager's Information Overload: The Impact of Coping Strategies on Decision-Making Performance*, Promotor: Prof. dr. H.G. van Dissel, EPS-2006-077-LIS, ISBN: 90-5892-111-5, http://hdl.handle.net/1765/7329

Iwaarden, J.D. van, *Changing Quality Controls: The Effects of Increasing Product Variety and Shortening Product Life Cycles,* Promotors: Prof. dr. B.G. Dale & Prof. dr. A.R.T. Williams, EPS-2006-084-ORG, ISBN: 90-5892-117-4, http://hdl.handle.net/1765/7992

Jansen, J.J.P., *Ambidextrous Organizations*, Promotors: Prof. dr. ir. F.A.J. Van den Bosch & Prof. dr. H.W. Volberda, EPS-2005-055-STR, ISBN: 90-5892-081-X, http://hdl.handle.net/1765/6774

Jennen, M.G.J., *Empirical Essays on Office Market Dynamics*, Promotors: Prof. dr. C.G. Koedijk & Prof. dr. D. Brounen, EPS-2008-140-F&A, ISBN: 978-90-5892-176-5, http://hdl.handle.net/1765/1

Jong, C. de, *Dealing with Derivatives: Studies on the Role, Informational Content and Pricing of Financial Derivatives*, Promotor: Prof. dr. C.G. Koedijk, EPS-2003-023-F&A, ISBN: 90-5892-043-7, http://hdl.handle.net/1765/1043

Keizer, A.B., *The Changing Logic of Japanese Employment Practices: A Firm-Level Analysis of Four Industries,* Promotors: Prof. dr. J.A. Stam & Prof. dr. J.P.M. Groenewegen, EPS-2005-057-ORG, ISBN: 90-5892-087-9, http://hdl.handle.net/1765/6667

Kijkuit, R.C., *Social Networks in the Front End: The Organizational Life of an Idea,* Promotor: Prof. dr. B. Nooteboom, EPS-2007-104-ORG, ISBN: 90-5892-137-6, http://hdl.handle.net/1765/10074

Kippers, J., *Empirical Studies on Cash Payments,* Promotor: Prof. dr. Ph.H.B.F. Franses, EPS-2004-043-F&A, ISBN: 90-5892-069-0, http://hdl.handle.net/1765/1520

Klein, M.H., *Poverty Alleviation through Sustainable Strategic Business Models: Essays on Poverty Alleviation as a Business Strategy,* Promotor: Prof. dr. H.R. Commandeur, EPS-2008-135-STR, ISBN: 978-90-5892-168-0, http://hdl.handle.net/1765/1

Kole, E., *On Crises, Crashes and Comovements*, Promotors: Prof. dr. C.G. Koedijk & Prof. dr. M.J.C.M. Verbeek, EPS-2006-083-F&A, ISBN: 90-5892-114-X, http://hdl.handle.net/1765/7829

Kooij-de Bode, J.M., *Distributed Information and Group Decision-Making: Effects of Diversity and Affect*, Promotor: Prof. dr. D.L. van Knippenberg, EPS-2007-115-ORG, http://hdl.handle.net/1765/10722

Knapp, S., *The Econometrics of Maritime Safety: Recommendations to Enhance Safety at Sea*, Promotor: Prof. dr. Ph.H.B.F. Franses, EPS-2007-096-ORG, ISBN: 90-5892-127-1, http://hdl.handle.net/1765/7913

Koppius, O.R., *Information Architecture and Electronic Market Performance*, Promotors: Prof. dr. P.H.M. Vervest & Prof. dr. ir. H.W.G.M. van Heck, EPS-2002-013-LIS, ISBN: 90-5892-023-2, http://hdl.handle.net/1765/921

Kotlarsky, J., *Management of Globally Distributed Component-Based Software Development Projects,* Promotor: Prof. dr. K. Kumar, EPS-2005-059-LIS, ISBN: 90-5892-088-7, http://hdl.handle.net/1765/6772

Kuilman, J., *The Re-Emergence of Foreign Banks in Shanghai: An Ecological Analysis,* Promotor: Prof. dr. B. Krug, EPS-2005-066-ORG, ISBN: 90-5892-096-8, http://hdl.handle.net/1765/6926

Langen, P.W. de, *The Performance of Seaport Clusters: A Framework to Analyze Cluster Performance and an Application to the Seaport Clusters of Durban, Rotterdam and the Lower Mississippi*, Promotors: Prof. dr. B. Nooteboom & Prof. drs. H.W.H. Welters, EPS-2004-034-LIS, ISBN: 90-5892-056-9, http://hdl.handle.net/1765/1133

Le Anh, T., *Intelligent Control of Vehicle-Based Internal Transport Systems*, Promotors: Prof. dr. M.B.M. de Koster & Prof. dr. ir. R. Dekker, EPS-2005-051-LIS, ISBN: 90-5892-079-8, http://hdl.handle.net/1765/6554

Le-Duc, T., *Design and Control of Efficient Order Picking Processes*, Promotor: Prof. dr. M.B.M. de Koster, EPS-2005-064-LIS, ISBN: 90-5892-094-1, http://hdl.handle.net/1765/6910

Leeuwen, E.P. van, *Recovered-Resource Dependent Industries and the Strategic Renewal of Incumbent Firm: A Multi-Level Study of Recovered Resource Dependence Management and Strategic Renewal in the European Paper and Board Industry*, Promotors: Prof. dr. ir. F.A.J. Van den Bosch & Prof. dr. H.W. Volberda, EPS-2007-109-STR, ISBN: 90-5892-140-6, http://hdl.handle.net/1765/10183

Lentink, R.M., *Algorithmic Decision Support for Shunt Planning*, Promotors: Prof. dr. L.G. Kroon & Prof. dr. ir. J.A.E.E. van Nunen, EPS-2006-073-LIS, ISBN: 90-5892-104-2, http://hdl.handle.net/1765/7328

Liang, G., *New Competition: Foreign Direct Investment and Industrial Development in China,* Promotor: Prof. dr. R.J.M. van Tulder, EPS-2004-047-ORG, ISBN: 90-5892-073-9, http://hdl.handle.net/1765/1795

Liere, D.W. van, *Network Horizon and the Dynamics of Network Positions: A Multi-Method Multi-Level Longitudinal Study of Interfirm Networks,* Promotor: Prof. dr. P.H.M. Vervest, EPS-2007-105-LIS, ISBN: 90-5892-139-0, http://hdl.handle.net/1765/10181

Loef, J., *Incongruity between Ads and Consumer Expectations of Advertising*, Promotors: Prof. dr. W.F. van Raaij & Prof. dr. G. Antonides, EPS-2002-017-MKT, ISBN: 90-5892-028-3, http://hdl.handle.net/1765/869

Maeseneire, W., de, *Essays on Firm Valuation and Value Appropriation,* Promotor: Prof. dr. J.T.J. Smit, EPS-2005-053-F&A, ISBN: 90-5892-082-8, http://hdl.handle.net/1765/6768

Londoño, M. del Pilar, *Institutional Arrangements that Affect Free Trade Agreements: Economic Rationality Versus Interest Groups*, Promotors: Prof. dr. H.E. Haralambides & Prof. dr. J.F. Francois, EPS-2006-078-LIS, ISBN: 90-5892-108-5, http://hdl.handle.net/1765/7578

Maas, A.A., van der, *Strategy Implementation in a Small Island Context: An Integrative Framework,* Promotor: Prof. dr. H.G. van Dissel, EPS-2008-127-LIS, ISBN: 978-90-5892-160-4, http://hdl.handle.net/1765/1

Maeseneire, W., de, *Essays on Firm Valuation and Value Appropriation,* Promotor: Prof. dr. J.T.J. Smit, EPS-2005-053-F&A, ISBN: 90-5892-082-8, http://hdl.handle.net/1765/6768

Mandele, L.M., van der, *Leadership and the Inflection Point: A Longitudinal Perspective*, Promotors: Prof. dr. H.W. Volberda & Prof. dr. H.R. Commandeur, EPS-2004-042-STR, ISBN: 90-5892-067-4, http://hdl.handle.net/1765/1302

Meer, J.R. van der, *Operational Control of Internal Transport*, Promotors: Prof. dr. M.B.M. de Koster & Prof. dr. ir. R. Dekker, EPS-2000-001-LIS, ISBN: 90-5892-004-6, http://hdl.handle.net/1765/859

Mentink, A., *Essays on Corporate Bonds*, Promotor: Prof. dr. A.C.F. Vorst, EPS-2005-070-F&A, ISBN: 90-5892-100-X, http://hdl.handle.net/1765/7121

Meyer, R.J.H., *Mapping the Mind of the Strategist: A Quantitative Methodology for Measuring the Strategic Beliefs of Executives*, Promotor: Prof. dr. R.J.M. van Tulder, EPS-2007-106-ORG, ISBN: 978-90-5892-141-3, http://hdl.handle.net/1765/10182

Miltenburg, P.R., *Effects of Modular Sourcing on Manufacturing Flexibility in the Automotive Industry: A Study among German OEMs*, Promotors: Prof. dr. J. Paauwe & Prof. dr. H.R. Commandeur, EPS-2003-030-ORG, ISBN: 90-5892-052-6, http://hdl.handle.net/1765/1039

Moerman, G.A., *Empirical Studies on Asset Pricing and Banking in the Euro Area,* Promotor: Prof. dr. C.G. Koedijk, EPS-2005-058-F&A, ISBN: 90-5892-090-9, http://hdl.handle.net/1765/6666

Mol, M.M., *Outsourcing, Supplier-relations and Internationalisation: Global Source Strategy as a Chinese Puzzle*, Promotor: Prof. dr. R.J.M. van Tulder, EPS-2001-010-ORG, ISBN: 90-5892-014-3, http://hdl.handle.net/1765/355

Mom, T.J.M., *Managers' Exploration and Exploitation Activities: The Influence of Organizational Factors and Knowledge Inflows*, Promotors: Prof. dr. ir. F.A.J. Van den Bosch & Prof. dr. H.W. Volberda, EPS-2006-079-STR, ISBN: 90-5892-116-6, http://hdl.handle.net/1765

Mulder, A., *Government Dilemmas in the Private Provision of Public Goods*, Promotor: Prof. dr. R.J.M. van Tulder, EPS-2004-045-ORG, ISBN: 90-5892-071-2, http://hdl.handle.net/1765/1790

Muller, A.R., *The Rise of Regionalism: Core Company Strategies Under The Second Wave of Integration*, Promotor: Prof. dr. R.J.M. van Tulder, EPS-2004-038-ORG, ISBN: 90-5892-062-3, http://hdl.handle.net/1765/1272

Nalbantov G.I., *Essays on Some Recent Penalization Methods with Applications in Finance and Marketing*, Promotor: Prof. drP.J.F. Groenen, EPS-2008-132-F&A, ISBN: 978-90-5892-166-6, http://hdl.handle.net/1765/1

Nguyen, T.T., *Capital Structure, Strategic Competition, and Governance*, Promotor: Prof. dr. A. de Jong, EPS-2008-148-F&A, ISBN: 90-5892-178-9, http://hdl.handle.net/1765/1

Ning, H., *Hierarchical Portfolio Management: Theory and Applications*, Promotor: Prof. dr. J. Spronk, EPS-2007-118-F&A, ISBN: 90-5892-152-9, http://hdl.handle.net/1765/10868

Noeverman, J., *Management Control Systems, Evaluative Style, and Behaviour: Exploring the Concept and Behavioural Consequences of Evaluative Style*, Promotors: Prof. dr. E.G.J. Vosselman & Prof. dr. A.R.T. Williams, EPS-2007-120-F&A, ISBN: 90-5892-151-2, http://hdl.handle.net/1765/10869

Oosterhout, J., van, *The Quest for Legitimacy: On Authority and Responsibility in Governance*, Promotors: Prof. dr. T. van Willigenburg & Prof.mr. H.R. van Gunsteren, EPS-2002-012-ORG, ISBN: 90-5892-022-4, http://hdl.handle.net/1765/362

Paape, L., *Corporate Governance: The Impact on the Role, Position, and Scope of Services of the Internal Audit Function*, Promotors: Prof. dr. G.J. van der Pijl & Prof. dr. H. Commandeur, EPS-2007-111-MKT, ISBN: 90-5892-143-7, http://hdl.handle.net/1765/10417

Pak, K., *Revenue Management: New Features and Models*, Promotor: Prof. dr. ir. R. Dekker, EPS-2005-061-LIS, ISBN: 90-5892-092-5, http://hdl.handle.net/1765/362/6771

Pattikawa, L.H, *Innovation in the Pharmaceutical Industry: Evidence from Drug Introduction in the U.S.*, Promotors: Prof. dr. H.R.Commandeur, EPS-2007-102-MKT, ISBN: 90-5892-135-2, http://hdl.handle.net/1765/9626

Peeters, L.W.P., *Cyclic Railway Timetable Optimization*, Promotors: Prof. dr. L.G. Kroon & Prof. dr. ir. J.A.E.E. van Nunen, EPS-2003-022-LIS, ISBN: 90-5892-042-9, http://hdl.handle.net/1765/429

Pietersz, R., *Pricing Models for Bermudan-style Interest Rate Derivatives*, Promotors: Prof. dr. A.A.J. Pelsser & Prof. dr. A.C.F. Vorst, EPS-2005-071-F&A, ISBN: 90-5892-099-2, http://hdl.handle.net/1765/7122

Poel, A.M. van der, *Empirical Essays in Corporate Finance and Financial Reporting*, Promotors: Prof. dr. A. de Jong & Prof. dr. G.M.H. Mertens, EPS-2007-133-F&A, ISBN: 978-90-5892-165-9, http://hdl.handle.net/1765/1

Popova, V., *Knowledge Discovery and Monotonicity*, Promotor: Prof. dr. A. de Bruin, EPS-2004-037-LIS, ISBN: 90-5892-061-5, http://hdl.handle.net/1765/1201

Pouchkarev, I., *Performance Evaluation of Constrained Portfolios*, Promotors: Prof. dr. J. Spronk & Dr. W.G.P.M. Hallerbach, EPS-2005-052-F&A, ISBN: 90-5892-083-6, http://hdl.handle.net/1765/6731

Prins, R., *Modeling Consumer Adoption and Usage of Value-Added Mobile Services*, Promotors: Prof. dr. Ph.H.B.F. Franses & Prof. dr. P.C. Verhoef, EPS-2008-128-MKT, ISBN: 978/90-5892-161-1, http://hdl.handle.net/1765/1

Puvanasvari Ratnasingam, P., *Interorganizational Trust in Business to Business E-Commerce*, Promotors: Prof. dr. K. Kumar & Prof. dr. H.G. van Dissel, EPS-2001-009-LIS, ISBN: 90-5892-017-8, http://hdl.handle.net/1765/356

Quak, H.J., *Sustainability of Urban Freight Transport: Retail Distribution and Local Regulation in Cities*, Promotor: Prof. dr.M.B.M. de Koster, EPS-2008-124-LIS, ISBN: 978-90-5892-154-3, http://hdl.handle.net/1765/11990

Radkevitch, U.L, *Online Reverse Auction for Procurement of Services*, Promotor: Prof. dr. ir. H.W.G.M. van Heck, EPS-2008-137-LIS, ISBN: 978-90-5892-171-0, http://hdl.handle.net/1765/1

Rinsum, M. van, *Performance Measurement and Managerial Time Orientation*, Promotor: Prof. dr. F.G.H. Hartmann, EPS-2006-088-F&A, ISBN: 90-5892-121-2, http://hdl.handle.net/1765/7993

Romero Morales, D., *Optimization Problems in Supply Chain Management*, Promotors: Prof. dr. ir. J.A.E.E. van Nunen & Dr. H.E. Romeijn, EPS-2000-003-LIS, ISBN: 90-9014078-6, http://hdl.handle.net/1765/865

Roodbergen, K.J., *Layout and Routing Methods for Warehouses*, Promotors: Prof. dr. M.B.M. de Koster & Prof. dr. ir. J.A.E.E. van Nunen, EPS-2001-004-LIS, ISBN: 90-5892-005-4, http://hdl.handle.net/1765/861

Rook, L., *Imitation in Creative Task Performance*, Promotor: Prof. dr. D.L. van Knippenberg, EPS-2008-125-ORG, http://hdl.handle.net/1765/11555

Schauten, M.B.J., *Valuation, Capital Structure Decisions and the Cost of Capital,* Promotors: Prof. dr. J. Spronk & Prof. dr. D. van Dijk, EPS-2008-134-F&A, ISBN: 978-90-5892-172-7, http://hdl.handle.net/1765/1

Schramade, W.L.J., *Corporate Bonds Issuers,* Promotor: Prof. dr. A. De Jong, EPS-2006-092-F&A, ISBN: 90-5892-125-5, http://hdl.handle.net/1765/8191

Schweizer, T.S., *An Individual Psychology of Novelty-Seeking, Creativity and Innovation,* Promotor: Prof. dr. R.J.M. van Tulder, EPS-2004-048-ORG, ISBN: 90-5892-077-1, http://hdl.handle.net/1765/1818

Six, F.E., *Trust and Trouble: Building Interpersonal Trust Within Organizations*, Promotors: Prof. dr. B. Nooteboom & Prof. dr. A.M. Sorge, EPS-2004-040-ORG, ISBN: 90-5892-064-X, http://hdl.handle.net/1765/1271

Slager, A.M.H., *Banking across Borders*, Promotors: Prof. dr. R.J.M. van Tulder & Prof. dr. D.M.N. van Wensveen, EPS-2004-041-ORG, ISBN: 90-5892-066–6, http://hdl.handle.net/1765/1301

Sloot, L., *Understanding Consumer Reactions to Assortment Unavailability*, Promotors: Prof. dr. H.R. Commandeur, Prof. dr. E. Peelen & Prof. dr. P.C. Verhoef, EPS-2006-074-MKT, ISBN: 90-5892-102-6, http://hdl.handle.net/1765/7438

Smit, W., *Market Information Sharing in Channel Relationships: Its Nature, Antecedents and Consequences*, Promotors: Prof. dr. ir. G.H. van Bruggen & Prof. dr. ir. B. Wierenga, EPS-2006-076-MKT, ISBN: 90-5892-106-9, http://hdl.handle.net/1765/7327

Sonnenberg, M., *The Signalling Effect of HRM on Psychological Contracts of Employees: A Multi-level Perspective*, Promotor: Prof. dr. J. Paauwe, EPS-2006-086-ORG, ISBN: 90-5892-119-0, http://hdl.handle.net/1765/7995

Speklé, R.F., *Beyond Generics: A closer Look at Hybrid and Hierarchical Governance*, Promotor: Prof. dr. M.A. van Hoepen RA, EPS-2001-008-F&A, ISBN: 90-5892-011-9, http://hdl.handle.net/1765/357

Szkudlarek, B.A., *Spinning the Web of Reentry: [Re]connecting reentry training theory and practice*, Promotor: Prof. dr. S.J. Magala, EPS-2008-143-ORG, ISBN: 978-90-5892-177-2, http://hdl.handle.net/1765/1

Teunter, L.H., *Analysis of Sales Promotion Effects on Household Purchase Behavior*, Promotors: Prof. dr. ir. B. Wierenga & Prof. dr. T. Kloek, EPS-2002-016-MKT, ISBN: 90-5892-029-1, http://hdl.handle.net/1765/868

Tims, B., *Empirical Studies on Exchange Rate Puzzles and Volatility*, Promotor: Prof. dr. C.G. Koedijk, EPS-2006-089-F&A, ISBN: 90-5892-113-1, http://hdl.handle.net/1765/8066

Tuk, M.A., *Empirical Studies on Exchange Rate Puzzles and Volatility*, Promotors: Prof. dr. ir. A. Smidts & Prof.dr. D.H.J. Wigboldus, EPS-2008-130-MKT, ISBN: 978-90-5892-164-2, http://hdl.handle.net/1765/1

Valck, K. de, *Virtual Communities of Consumption: Networks of Consumer Knowledge and Companionship*, Promotors: Prof. dr. ir. G.H. van Bruggen & Prof. dr. ir. B. Wierenga, EPS-2005-050-MKT, ISBN: 90-5892-078-X, http://hdl.handle.net/1765/6663

Valk, W. van der, *Buyer-Seller Interaction Patterns During Ongoing Service Exchange*, Promotors: Prof. dr. J.Y.F. Wynstra & Prof. dr. ir. B. Axelsson, EPS-2007-116-MKT, ISBN: 90-5892-146-8, http://hdl.handle.net/1765/10856

Verheul, I., *Is There a (Fe)male Approach? Understanding Gender Differences in Entrepreneurship*, Prof. dr. A.R. Thurik, EPS-2005-054-ORG, ISBN: 90-5892-080-1, http://hdl.handle.net/1765/2005

Vis, I.F.A., *Planning and Control Concepts for Material Handling Systems*, Promotors: Prof. dr. M.B.M. de Koster & Prof. dr. ir. R. Dekker, EPS-2002-014-LIS, ISBN: 90-5892-021-6, http://hdl.handle.net/1765/866

Vlaar, P.W.L., *Making Sense of Formalization in Interorganizational Relationships: Beyond Coordination and Control,* Promotors: Prof. dr. ir. F.A.J. Van den Bosch & Prof. dr. H.W. Volberda, EPS-2006-075-STR, ISBN 90-5892-103-4, http://hdl.handle.net/1765/7326

Vliet, P. van, *Downside Risk and Empirical Asset Pricing*, Promotor: Prof. dr. G.T. Post, EPS-2004-049-F&A, ISBN: 90-5892-07-55, http://hdl.handle.net/1765/1819

Vlist, P. van der, *Synchronizing the Retail Supply Chain*, Promotors: Prof. dr. ir. J.A.E.E. van Nunen & Prof. dr. A.G. de Kok, EPS-2007-110-LIS, ISBN: 90-5892-142-0, http://hdl.handle.net/1765/10418

Vries-van Ketel E. de, *How Assortment Variety Affects Assortment Attractiveness: A Consumer Perspective*, Promotors: Prof. dr. G.H. van Bruggen & Prof. dr. ir. A. Smidts, EPS-2006-072-MKT, ISBN: 90-5892-101-8, http://hdl.handle.net/1765/7193

Vromans, M.J.C.M., *Reliability of Railway Systems*, Promotors: Prof. dr. L.G. Kroon, Prof. dr. ir. R. Dekker & Prof. dr. ir. J.A.E.E. van Nunen, EPS-2005-062-LIS, ISBN: 90-5892-089-5, http://hdl.handle.net/1765/6773

Vroomen, B.L.K., *The Effects of the Internet, Recommendation Quality and Decision Strategies on Consumer Choice*, Promotor: Prof. dr. Ph.H.B.F. Franses, EPS-2006-090-MKT, ISBN: 90-5892-122-0, http://hdl.handle.net/1765/8067

Waal, T. de, *Processing of Erroneous and Unsafe Data*, Promotor: Prof. dr. ir. R. Dekker, EPS-2003-024-LIS, ISBN: 90-5892-045-3, http://hdl.handle.net/1765/870

Watkins Fassler, K., *Macroeconomic Crisis and Firm Performance,* Promotors: Prof. dr. J. Spronk & Prof. dr. D.J. van Dijk, EPS-2007-103-F&A, ISBN: 90-5892-138-3, http://hdl.handle.net/1765/10065

Wennekers, A.R.M., *Entrepreneurship at Country Level: Economic and Non-Economic Determinants,* Promotor: Prof. dr. A.R. Thurik, EPS-2006-81-ORG, ISBN: 90-5892-115-8, http://hdl.handle.net/1765/7982

Wielemaker, M.W., *Managing Initiatives: A Synthesis of the Conditioning and Knowledge-Creating View,* Promotors: Prof. dr. H.W. Volberda & Prof. dr. C.W.F. Baden-Fuller, EPS-2003-28-STR, ISBN: 90-5892-050-X, http://hdl.handle.net/1765/1042

Wijk, R.A.J.L. van, *Organizing Knowledge in Internal Networks: A Multilevel Study*, Promotor: Prof. dr. ir. F.A.J. van den Bosch, EPS-2003-021-STR, ISBN: 90-5892-039-9, http://hdl.handle.net/1765/347

Yu, M, *Enhancing Warehouse Performance by Efficient Order Picking*, Promotor: Prof. dr. M.B.M. de Koster, EPS-2008-139-LIS, ISBN: 978-90-5892-167-3, http://hdl.handle.net/1765/1

Zhang, X., *Strategizing of Foreign Firms in China: An Institution-based Perspective*, Promotor: Prof. dr. B. Krug, EPS-2007-114-ORG, ISBN: 90-5892-147-5, http://hdl.handle.net/1765/10721

Zhu, Z., *Essays on China's Tax System*, Promotors: Prof. dr. B. Krug & Prof. dr. G.W.J. Hendrikse, EPS-2007-112-ORG, ISBN: 90-5892-144-4, http://hdl.handle.net/1765/10502

Zwart, G.J. de, *Empirical Studies on Financial Markets: Private Equity, Corporate Bonds and Emerging Markets*, Promotors: Prof. dr. M.J.C.M. Verbeek & Prof. dr. D.J.C. van Dijk, EPS-2008-131-F&A, ISBN: 978-90-5892-163-5, http://hdl.handle.net/1765/1

Erasmus Research Institute of Management - ERIM

Design & layout: B&T Ontwerp en advies (www.b-en-t.nl) Print: Haveka (www.haveka.nl)

GLOBALIZATION OF R&D

LEVERAGING OFFSHORING FOR INNOVATIVE CAPABILITY AND ORGANIZATIONAL FLEXIBILITY

Within the realm of globalization of R&D, offshoring is a relatively recent and still emerging phenomenon. Rooted in the notion of comparative advantage, offshoring of R&D involves disaggregation and global distribution of the firm's R&D value chain activities to leverage innovation capacity of low-cost countries. Characteristically different from market- and technology-seeking globalization of R&D, offshoring is motivated by the intertwining competitive needs to gain efficiency and access knowledge resources. This study represents a systematic, grounds-up attempt to explore the terrain of the phenomenon of offshoring of R&D and its influence on the competitive advantage of firms. Specifically, going beyond structural cost savings, the research examines the link between offshoring of R&D and the firm's innovative capability and organizational flexibility-the two most important organizational capabilities of high technology firms. Employing an interpretive approach, the research includes multiple case studies of intra-firm and inter-firm offshoring of software R&D across a range of industries. The study demonstrates that by strategically organizing and managing offshoring of R&D, firms can significantly enhance their innovative capability and organizational flexibility. The findings suggest that offshoring of R&D is a new global organizational form that not only serves as an adaptive device but also allows firms to achieve ambidexterity.

ERIM

The Erasmus Research Institute of Management (ERIM) is the Research School (Onderzoekschool) in the field of management of the Erasmus University Rotterdam. The founding participants of ERIM are Rotterdam School of Management (RSM), and the Erasmus School of Economics (ESE). ERIM was founded in 1999 and is officially accredited by the Royal Netherlands Academy of Arts and Sciences (KNAW). The research undertaken by ERIM is focussed on the management of the firm in its environment, its intra- and interfirm relations, and its business processes in their interdependent connections.

The objective of ERIM is to carry out first rate research in management, and to offer an advanced doctoral programme in Research in Management. Within ERIM, over three hundred senior researchers and PhD candidates are active in the different research programmes. From a variety of academic backgrounds and expertises, the ERIM community is united in striving for excellence and working at the forefront of creating new business knowledge.

ERIM PhD Series

Research in Management

Erasmus Research Institute of Management - **ERIM**
Rotterdam School of Management (RSM)
Erasmus School of Economics (ESE)
P.O. Box 1738, 3000 DR Rotterdam
The Netherlands

Tel.	+31 10 408 11 82
Fax	+31 10 408 96 40
E-mail	info@erim.eur.nl
Internet	www.erim.eur.nl