



**KTH Industrial Engineering
and Management**

The Collaborative Challenge of Product Development

Exploring Sustainable Work Systems Through
Critical Incidents in R&D Alliances

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Doctoral Thesis
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ABSTRACT

The aim of this thesis is to empirically study challenges and opportunities in the operational work in contract-based R&D alliances in order to increase the understanding of this type of work system and explore how these work systems could be sustainable. Based on the concept of sustainable work systems, this thesis addresses issues of how work in R&D alliance should support both the competitiveness of the firm as well as regeneration of human resources.

In the area of product development, the main drivers for creating alliances are often strategic and concern the globalization of today's business environment. Issues such as increased cost-based competition, shorter product life cycles, and a greater need for flexibility to tackle technological or strategic shifts have all been argued to motivate companies to form R&D alliances. No doubt adopting the firm's development of new products to an R&D alliance strategy has a substantial impact on the operational work. However, despite the vast research on why companies engage in R&D alliances, the knowledge of operational work and how they are operationally managed is still limited. Several scholars have recently reported that failed operations may be one of the most important reasons for situations where R&D alliances do not reach their goals.

An empirical investigation covering 14 R&D alliances has been conducted based on the Critical Incident Technique. The findings – supported by 158 critical incidents, which have been identified by operational leaders – reveal new knowledge about the R&D alliance operational work with implications for both competitiveness and regeneration of human resources.

A central contribution stems from the specific insights given to challenges and opportunities that operational leaders face in the R&D alliance work, in five perspectives on the R&D alliance process: *Formation*, *Formal R&D process*, *Informal relationships*, *Embeddedness*, and *Exit*. Further examination of the critical incident data showed several implications for operational leaders with direct contributions to both product development and alliance theory. First, four critical roles for operational leaders in R&D alliances have been suggested: *Facilitating*, *Finishing*, *Ambassadoring*, and *Trustkeeping*. Secondly, a framework of trust formation mechanisms has been applied and tested. This concluded that *process-based*, *characteristic-based*, and *institutional-based mechanisms* represent important aspects in alliance operation; the relevance of these trust formation mechanisms contributes both to the knowledge of micro-processes of trust formation and specific managerial abilities in R&D alliances. Third, we examine the influence of two types of contextual risks that have been addressed in previous alliance research: *relational* and *performance risks*. The comparative analysis of a sub-sample of alliances shows that these risks influence the operational work in R&D alliances for which operational leaders could be specifically trained and prepared. Lastly, a framework that addresses support from HRM in inter-organizational context has been developed and analyzed. This has indicated that HRM represents an important, although unexploited, resource when engaging in R&D alliances.

Furthermore, we have suggested a tentative framework for the R&D alliance as a sustainable work system. The overall findings from this study have been synthesized from a sustainable work systems perspective, based on three organizational principles that have been drawn from practice-centered product innovation: *broadened roles and responsibilities*, *work as a collaborative process*, and *decentralization of strategic information*. A fourth principle has been incorporated as well: *support systems for sustainable work*. This concluded that, in order to be sustainable, companies that engage in R&D alliances should carefully manage and reassess the consequences of these organizational principles in order to simultaneously support the goals that are involved in this type of work system: to simultaneously support *innovation*, *inter-organizational relationships*, and *the regeneration of human resources*.

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Slakmöre, August 2009

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LIST OF APPENDED PAPERS

Paper 1

Kaulio, M.A. and Uppvall, L. (2009)¹. Critical Incidents in R&D Alliances: Uncovering Leadership Roles. *European Management Review*, 6(3): 195-205.

Paper 2

Uppvall, L. (2009)². Formation of Trust in R&D Alliances. *Submitted to European Journal of Innovation Management, September, 2009.*

Paper 3

Uppvall, L. (2009)³. Relational and Performance Risks in Operative Work in Contract-Based R&D Alliances. *Submitted to International Journal of Innovation and Technology Management, September, 2009.*

Paper 4

Uppvall, L. (2008)⁴. R&D Alliances: Operational and Top Management Challenges for HRM.

ADDITIONAL PUBLICATIONS

Book Chapters

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Reports

Hugnell, A., Kaulio, M., Packendorff, J. & Uppvall, L. (2004). *Plattform för virtuellt företagande*. Stockholm: KTH Engineering Institute.

¹ The two authors have contributed on an equal basis to the paper.

² A previous version of the paper appears In the Proceedings of the 12th International Product Development Management Conference, EIASM, Copenhagen, Denmark, June 14-16, 2005.

³ A previous version of the paper appears In the Proceedings of the 14th International Product Development Management Conference, EIASM, Porto, Portugal, June 11-12, 2007.

⁴ Slightly modified version of paper presented at the Workshop on HRM in Sweden, Gothenburg, Sweden, September 27-28, 2007.

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INTRODUCTION

In their quest to be competitive, companies face a wide range of complex challenges in today's world. For industrial companies, many of these challenges could be traced to the globalization of the economy and fast-evolving technologies (e.g. Doz and Hamel, 1998). Specifically, free trade and deregulations imply new market and growth opportunities for product developing companies, as well as the challenges from adapting to global market demands, lower prices, and reduced product life cycles as a result of an increased competition (e.g. Narula and Duysters, 2004). In addition, added customer value of products is often a result of a growing technological converges between sectors: for example, between computers and automobiles (e.g. Adamsson, 2007). As a result, products become increasingly complex and technology dense (Granstrand *et al.*, 1997).

No doubt the effects from globalization and the development of new technology have a substantial impact on how companies manage their product development activities. For example, adapting to new market demands, reducing product costs, shortening product life cycles, and handling increased technological complexity require more R&D resources and competences. In addition, new technology development and increased technology converges means that competences and resources have to be constantly adapted in order for a company to stay in the forefront of global competition.

However, despite these global market opportunities, few companies can afford to increase their spending or take the risks that are associated with all the demands that are currently put on product development. Instead, the first-best option for many companies is to increase their engagement in collaborations concerning development of new products (e.g. Duysters and de Man, 2003). In particular, the number of R&D alliances has grown rapidly over the past few decades (Hagedoorn, 2002; Narula and Duysters, 2004). The advantages of R&D alliances compared to, for example, acquisitions or in-house development of technology have been claimed to be numerous (Doz and Hamel, 1998; Narula and Duysters, 2004; Chesbrough *et al.* 2006). For example, by forming R&D alliances with technological specialized partners, companies can have access to new technology, share costs and risks without an equivalent expansion of the companies' own R&D resources and competences (e.g. Christensen, 2006). Moreover, the R&D alliance

allows companies to shift partners and, therefore, to be more flexible when managing strategic technology change, than if acquiring or developing resources and competences of their own (e.g. Granstrand *et al.*, 1997). In addition, the high pace of change in many industries implies that R&D collaborations are, in certain circumstances, the only realistic alternative to access specific technology and competences (Contractor and Lorange, 2002).

Although R&D alliances could be well motivated, they are also documented to be difficult to manage (Doz, 1996; Ariño and de la Torre, 1998; Sampson, 2005). Several scholars have recently reported that failed operations may be one of the most important reasons for situations where R&D alliances do not reach their goals or, worse, end up as complete failures (e.g. Sivadas and Dwyer, 2000; Salk, 2005). Although it is difficult to measure, estimates on R&D alliances failure rates are often as high as 50% (e.g. Sivadas and Dwyer, 2000; Reuer and Zollo, 2005). This implies that, in order to be successful in developing new products, a growing number of companies have to master the difficult task of inter-organizational collaborations as an integrated part of their operation. Nevertheless, despite the vast research on why companies engage in R&D alliances, the knowledge of operational work and how they are operationally managed is still limited (Gulati, 1998; Doz, 1996; Salk, 2005). For example, both Salk (2005) and Contractor (2005) claim that these aspects are some of the least studied areas in alliance research.

This thesis deals with collaborative product development. In particular, the focus is set on the operational work in R&D alliances in order to reveal what challenges and opportunities this work implies for the individual. Furthermore, by applying a sustainable work systems perspective, both economical and human values are explored. A preliminary formulation of the sustainable work system concept has been developed in Docherty, Forslin & Shani (2002). Based on this conceptualization of sustainable work systems, this thesis addresses issues of how work in R&D alliance should support both the competitiveness of the firm (i.e. a specific business strategy of the firm and performance at the operational level) as well as regeneration of human resources (i.e. human resources should not be consumed; instead, they should be able to grow from experience of work) (Docherty *et al.*, 2002a). Since research has indicated that high failure rates in inter-organizational relationships could be a consequence of complex operational and managerial settings, a focus on human resources regeneration in R&D alliances work might be specifically critical for the competitiveness of product-developing companies.

In addition, prior research that describes the work realities expected in the operative work in R&D alliances points to several demanding aspects that could be seen as critical in achieving regeneration of human resources and a good working life. First, work in product development is highly demanding, even if it does not involve collaborations with external partners. Reduced time to market for new products, as well as keeping up with rapid changes in technology, lead to high work intensity in product development work, which can be expected to drain human resources (e.g. Kira, 2002; Lewis *et al.*, 2002). Consumption of human resources on the individual level comes from imbalances between their resources and work related demands (Docherty *et al.*, 2002a). As a result, emotional and psychological exhaustion may lead to detachment from work, as well as inefficiency (Maslach and Leiter, 1997). On a group level, individual exhaustion could lead to collective negative spirals in these social systems. Instead of focusing on their tasks and goals, individuals and groups could turn inwards focusing on collectively constrain

anxieties (Hirschhorn, 1988). This is obviously a type of particularly negative behavior in the R&D alliance work. Secondly, uncertain and less formalized working realities could be expected in R&D alliance work. For example, formal structures and work routines in in-house product development may not fit or become contradictory in the inter-organizational environment (e.g. Ring and Van de Ven, 1994; Doz, 1996), which has been described as a particularly demanding work situation for the individual (Heckscher and Applegate, 1994; Kira and Forslin, 2008). Without the normal support from formal structures and an increased uncertainty, demands on individuals will be high: for example, responsibilities will increase and roles will be less defined, decisions must be based on an overall understanding of goals, concern for the partner's situation, etc. When adding these demands to the described tensions and high pace in ordinary product development, individuals will risk high levels of work intensity in R&D alliances work, which also could have particularly critical consequences for performance and competitiveness of the collaborating firms (Kira, 2002; Ring and Van de Ven, 1994). In the following, a short illustration (inspired by the empirical results of this study) indicate that some of these issues are a reality in R&D alliance work:

When Martin Nylund and Peter Gustavsson – both senior development engineers and project managers at AIRTECH – entered the meeting, they knew that the negotiation should be tough. During the past five months, two development teams – one from each company – had worked closely together with the design of the new machine. The task of the teams was to develop a top-of-the-line product with the double capacity of the current one. In this task, the management at AIRTECH had realized that they needed a partner. A German machine manufacturer was found that had long experience of designing complex machines, and an R&D alliance was formed. The alliance comprised cooperation during the design phase, as well as a revenue sharing agreement. Therefore, the technical competence of both organizations could be exploited and the cost, as well as the risk, could be shared.

The negotiation facing Martin and Peter did not address payments or economic compensation; it concerned a design decision that had to be taken: the change from a one-module design to a two-module parallel design. In practice, this meant that the conceptual design of the product had to be remade and, worse, that it was related to the part of the machine for which the Germans were responsible. From the perspective of AIRTECH, the design decision was clear: it had to be a parallel-module design if the product was to work with acceptable reliability. However, if the change request was approved, the original project plan - which the CEOs of each company had signed, accepted, and presented to their respective boards - had to be remade. As a consequence, Martin and Peter saw endless discussions about compensation for changes based on the usual “out of scope” argument; in the worst case scenario, even a renegotiation of the complete revenue sharing agreement, including the involvement of corporate lawyers from both sides.

This illustration gives a glimpse of what the R&D alliance work can offer in terms of uncertainty, negotiations, trust-building, etc. on the individual level. Hence, applying the concept of sustainable work systems to an empirical study of operational work in R&D alliances seems well motivated and could be expected to give an important contribution to both of the research areas of *collaborative product development* as well as *sustainable work systems*. That is to say, both the knowledge of how to be competitive as well as the secure regeneration of human resources in operative work in R&D alliances are essential aspects of how product and system developing companies could prosper in today's technology driven global economy.

AIM AND RESEARCH QUESTIONS

The aim of this thesis is to empirically study challenges and opportunities in the operational work in R&D alliances in order to increase the understanding of this type of work system and explore how these work systems could be sustainable.

Research Questions:

What do challenges and opportunities, as reflected in critical incidents in the R&D alliance work system, imply for operational leaders?

What implications do these results have on R&D alliances as sustainable work systems?

SCOPE OF THESIS

This thesis focuses on operational work in the specific type of contract-based R&D alliances. The methodological approach of the critical incidents technique implies a focus on specific situations and, thereby, limits the scope. Data has been collected based on interviews with operative leaders from one part in the studied R&D alliances; therefore, it only represents one party's view of the relationships. Moreover, the studied situations are evaluated as being critical for the outcome of the project – not as overall process efficiency or product success. Furthermore, work intensity and human resource consumption are explored based on the social and behavioral aspects in situations that are defined as critical incidents.

PARADIGM AND RESEARCH TRADITION

This thesis work has been conducted at the division of Industrial Work Science in the department of Industrial Economics and Management at The Royal Institute of Technology (KTH).

In this tradition, lies the acknowledgement of the individual and social aspects when studying managerial and operational aspects of work. The research is characterized by multi-disciplinary approaches and builds on theories such as leadership, organizational, and human-factors. One stream of recent research in this domain has been centered on the emerging field of sustainable work systems (Docherty, Forslin & Shani, 2002). In brief, sustainable work is grounded in a duality among requirements in the design of work systems, meaning that these should promote both sustainable *economical* and *human* values. Taking a historical view, such a dual focus has been a central theme since the emergence of this research. Already the pioneer of industrial work science, Frederick W. Taylor, focused in his *scientific management* approach on both systematic improvement of productivity in the work organization, as well as increased health of the employees (for example, by control of work load: Taylor, 1998/1911). Through the *human relations* school, the social needs of employees were positively related to the company's productivity; the polarization between exploitation of the worker and the profitability of the company were, therefore, seriously challenged (Gillespie, 1991). Later, other human needs were acknowledged, such as self-actualization and sense of meaningfulness in the *socio-technical system theory* (STST). In Table 1, this historical development process of some of the research paradigms related to industrial work science are tentatively summarized and associated with economical objectives and social values that are the focus in these theories.

Table 1. Economy and Welfare. Source: Brödner and Forslin (2002)

	Economic objectives	Social values
Adam Smith	Productivity by horizontal division of labor	Subsistence
Scientific management	Rationalization of work Reduced strife	Material welfare Reduced human wear
Human relations	Productivity by social consideration	Fulfilling social needs
Socio-technical systems	External efficiency Internal self-regulation	Fulfilling psychological job demands
Sustainable work systems	Competitiveness	Generative use of human and social resources

Compared to earlier approaches, the sustainable work systems concept could be claimed to be more holistic by focusing on the competitiveness of the firm (as the economic value) and a regenerative, growth based, view on the human and social resources (as the social value). As such, the concept of sustainable work systems is a reaction to a witnessed increase in work intensity from actions that is taken in many of today's organizations when trying to stay competitive in a global business environment. Unfortunately, not only has the increased work intensity lead to a human toll (such as stress and burnout, e.g. Maslach and Leiter, 1997), related effects on operational quality and performance are

claimed to have negative effects also on the organizations' competitiveness (Brödner and Forslin, 2002).

Therefore, applying the approach of sustainable work systems on R&D alliances could be an important contribution to this field of research. Particularly since alliances are such a direct and growing way for product development companies to stay competitive (Narula and Duysters, 2004), as well as representative of a type of work with specific risks of high work intensity (Olin and Shani, 2003). Along with recent published work in the area related to sustainable work systems from the department of Industrial Work Science at KTH, (for example, Kira (2003), Dabhilkar (2006), Åteg (2006), Palm (2008), and Hemphälä (2008), this thesis work aims to contribute to the knowledge of how new organizational approaches could improve employee well-being and enhance organizational efficiency and competitiveness.

R&D ALLIANCES AND WORK SYSTEMS

Two concepts are fundamental in framing the area of inquiry in this thesis. These are the concepts of *R&D alliances* and *work systems*. Therefore, before going into the theoretical frame, these two key concepts will be shortly elaborated upon - starting with the alliance.

Alliances are a very diverse phenomenon, and finding a common typology and distinct definitions for different types of inter-organizational relationships seems to be a challenge for scholars. In absence of consensus regarding typology and definitions, a short review of how these matters are viewed in this thesis will be given; a specific focus will be on the definition of an R&D alliance.

The notion of inter-organizational relationships is used as a broad concept for inter-organizational collaborations, spanning over several different types of legal agreements: from supplier relations to collaborations including different degree of formal ownership (as described in Figure 1). Several of the operational and work related issues central to this work could be seen as depending on the type collaborative agreement in use: for example, the level of integration or the amount of formal power through equity-holding between the partners (e.g. Das and Teng, 2001a). Therefore, it is essential to explicitly define the type of inter-organizational relation applied in specific studies. This has not always been the case in prior research (Contractor, 2005). The aim of Figure 1 is to clarify how the contract-based alliance is defined in relation to other types of collaborative agreements and how these relate to the level of integration between the partners.

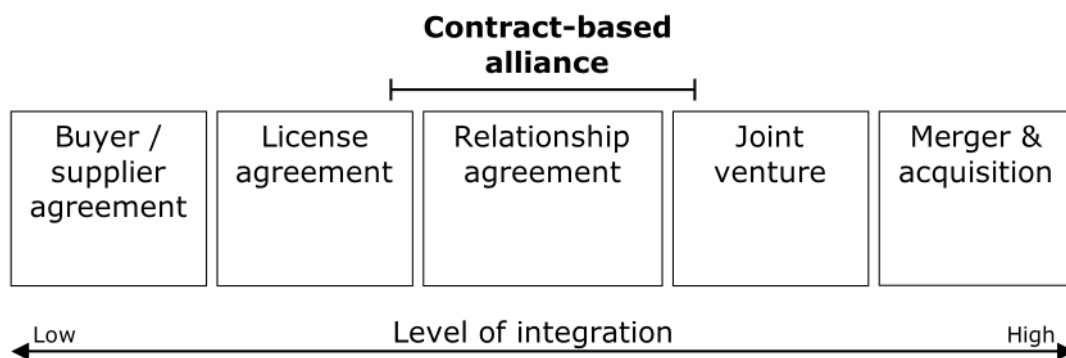


Figure 1. Contract-based alliance in relation to other legal agreements of cooperation.

According to Figure 1, the conception of a contract-based alliance is situated between the legal agreements of license agreement and joint venture, in terms of inter-organizational integration. A license agreement could be associated with close collaboration in highly strategic areas of the partners' operations. However, the license agreement represents a unilateral flow of, for example, technology, which distinguishes it from the mutual contract-based alliance (see definition below). Joint ventures, on the other hand, are more integrated in its operation than the contract-based alliance. This type of relationship could, for example, foster a specific venture culture and other more long-term organizational values by creating a common venture, based on shared ownership. Moreover, as also indicated in Figure 1, our view of a contract-based alliance could include some aspects of both license agreements and ownership between the partners' organizations. However, these aspects could not be a central part of the particular alliance relationship, which means that it could not be allowed to interfere with the intention of the mutual collaborative agreement that regulates a specific alliance relationship.

A contract-based alliance is defined in this research based on the following definition by Yoshino and Srinivasa (1995, p. 5): "(i) Two or more firms that unite to pursue a set of agreed upon goals remain independent subsequent to the formation of the alliance; (ii) The partner firms share the benefits of the alliance and control over the performance of assigned tasks – perhaps the most distinctive characteristics of alliances and the one that makes them so difficult to manage; and (iii) The partner firms contribute on a continuing basis in one or more key strategic areas, e.g., technology, products and so forth". A mutual contribution of resources to the joint work and a sharing of the benefits that independent partners achieve are, therefore, seen as the essence of a contract-based alliance.

Despite this definition, a number of additional aspects could influence the relationship. Such aspects could relate to the specific purpose of the collaboration or a difference in size between the partners. To define the specific case of an R&D alliance, this thesis will adapt the following criteria as a supplement to the definition above: the overall purpose of the alliance should refer to tasks carried out by the product development function and relate to new product development. That is to say, the product development work will not include development of, for example, the firms production system. Neither will it incorporate minor product upgrading nor product or service upgrading in the end of the product life cycle.

The second important concept running through this research is *work systems*. A work system is here seen to include all involved individuals, technical infrastructure, work processes, etc. that are engaged in accomplishing the goals of the organization. As such, Deming (2000, p. 50) defines a system as "a network of interdependent components that work together to try to accomplish the aim of the system."

Efficiency in work systems is becoming more and more dependent on flexibility at the price of rigidity (Docherty *et al.*, 2002a). For example, in product development there is a strong trend for integration between different functions to allow parallel processes in order to reduce development time and enhance innovation through the process (e.g. Gerwin and Barrowman, 2002; Olin and Shani, 2003). Therefore, many work systems are becoming more internally integrated in order to support flexibility. However, alliances span over organizational boundaries, which means that when organizations are involved

in such collaborations, the work systems also have to be externally integrated. It should, therefore, be pointed out that work systems are seen as open systems in the framing of this thesis. An open system approach implies that by being open to its surroundings and environment, then the work system is affected by, and affects, its surroundings (e.g. Pasmore and Sherwood, 1978). Thus, work systems in R&D alliances are expected to support both internal as well as external integration of product development work. Lastly, as will be discussed in the frame of reference, such demands on the work system are associated with particular risks of high work intensity and challenges in order to achieve sustainable work systems. Work intensity and sustainable work systems will, therefore, be defined according to Docherty *et al.* (2002a, p. 3) as following: “Work intensity refers to the consumption of human recourses – physical, cognitive, social, and emotional – in work organizations, while the sustainable work systems concept presents a vision for the future competitive organization in which human resources are regenerated and allowed to grow.”

STRUCTURE OF THE THESIS

The outline of the thesis follows the structure presented in Figure 2:

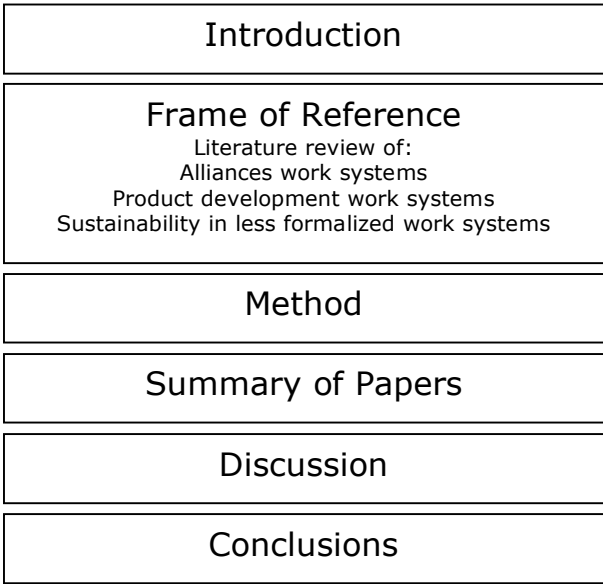


Figure 2. Structure of thesis.

Chapter 1 covers an **Introduction** including the background leading to the research problem, the aim of the study and the research questions, paradigm and research tradition, concepts of alliances and work systems, and structure of the thesis.

Chapter 2 presents the **Frame of Reference**. Starting with a brief review on why companies create alliances. A specific literature review on alliance and product development work systems then follows that includes work practices on the individual level. Thereafter, literature on less formalized work systems is reviewed with a specific focus on aspects of sustainability, including risks and opportunities for the individual related to work in R&D alliances.

Chapter 3 presents the **Method** applied, including the research strategy and the critical incidents method. A presentation of selection of respondents, data collection, and exploration of the data then follows. Lastly, a discussion on validity, generalizability, and reliability of the data is given.

Chapter 4 comprises a **Summary of Papers**. The summary includes an overview of the papers, which includes the purpose, the main findings, as well as an extraction of issues from each paper related to the aim of the thesis.

Chapter 5 presents the **Discussion**, starting with challenges and opportunities in the R&D alliance work system and what this implies for operational leaders. The results are then discussed from the sustainable work systems perspective, leading to a tentative framework to support sustainable work in R&D alliances.

Chapter 6 covers the **Conclusions**, limitations of the study, and suggestions for further research.

FRAME OF REFERENCE

Insights will be given in the first part of the frame of reference into the growing number of established R&D alliances, as well as the rationale behind why organizations engage in them. Literature on alliances and product development is then reviewed, taking a work system perspective. Since the aim of this thesis is to contribute to area of sustainable work systems, findings on the operative and individual levels will be specifically considered in both of these research areas. However, as will be shown, both of these streams of research (in particular the literature covering the alliance work system) have limitations when it comes to details about work practice on the individual level, how it could be expected to influence the individual, and how sustainability could also be achieved. Therefore, a third stream of research will be reviewed covering specific risks and opportunities for the individual in less formalized work systems. This literature addresses the change in organizations departing from bureaucratic structures toward less formalized work systems: here conceptualized as an ideal type of post-bureaucratic organization (Heckscher and Donnellon, 1994). Finally, literature taking a critical perspective on less formalized work systems is reviewed, including the emerging literature on sustainable work systems. This section will also address specific risks related to the reviewed literature on product development and alliances work systems, which could be seen as a contribution from this literature review and will, therefore, be used as a framework for exploring sustainability in R&D alliance work.

WHY COMPANIES FORM R&D ALLIANCES

Rapid changes in today's business environment forces companies to refine their business models to achieve and sustain growth and global competitiveness (e.g. Dyer, Kale, & Singh, 2004). Globalization of the economy and the speed of technological development are seen as the two major drivers influencing the way companies organize their R&D activities (Narula and Duystres, 2004; Doz and Hamel, 1998; Osborn and Baughn, 1990). Although the globalization has affected companies for at least a century (e.g. Laestadius, 1980), today's interdependence of locations and economic units across countries and regions influences the companies more than ever before (Narula, 2003; Castells, 2000).

Combined with the speed of technological development, resulting in even shorter product life cycles and more complex products and systems (e.g. Narula and Duysters, 2004; Dussauge and Garrette, 1999), have lead to great changes in how companies develop new products.

In this context, R&D alliances are seen as a tool for product developing companies to expand and adapt to various markets simultaneously, as well as handling increased costs and risks related to innovation (e.g. Duysters and De Man, 2003). The global growth of newly established R&D partnerships over the past few decades is shown in Figure 3. Although the trend is somewhat related to the business cycles of the world economy, the overall pattern demonstrates a strong drive for product developing companies to address their capabilities in managing R&D related collaborations both nationally and internationally.

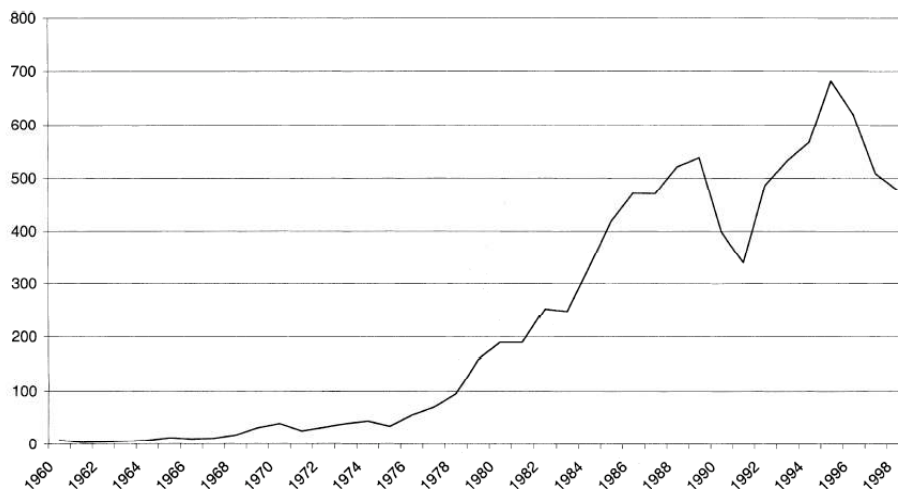


Figure 3. Growth of newly established R&D partnerships (1960-1998). Source: Hagedoorn (2002).

In addition, several studies involving the view of managers and executives indicate that the trend of creating strategic alliances will continue to grow, at least in a foreseeable future (Harbison and Pekar, 1997; Contractor and Lorange, 2002; Hughes and Weiss, 2007).

From a research perspective, it is no surprise that due to the highly strategic and competitive motive to conduct collaborative agreements, scholars who take an external view of the firm (e.g. by adopting a transaction cost perspective or a strategic view of resource or competence-based theory) has dominated the literature in this area.

Broadly, the evolution of strategic alliances has gone from being more of a tool for companies to reach new markets - often through an alliance with a local company - or to gain synergies from joint production plants to becoming more strategic in nature: such as R&D alliances (Narula and Duysters, 2004). Some researchers even talk about a new type or era of capitalism – that of alliance capitalism – in contrast to the older paradigm of hierarchical capitalism (Wikström et al, 1997, Dunning, 1995, 1997). In this era, the alliance increasingly represents the most suitable option for companies.

As aforementioned, increased competition is seen to be the main driver for the formation of alliances: that is to say, the need for lowered transaction costs and harmonization of markets (Williamson, 1991; Teece, 1989). Although from a technological point of view, the convergence of technologies and markets, as well as the rise in R&D costs combined

with the increasing complexity of products and shortening technology and product life cycles, are seen as specifically important drivers (e.g. Duysters and de Man, 2003).

Compared to alliances in prior periods (the 1960s and 1970s) four characteristics of recent alliances stand out (Narula and Dunning, 1998). First, alliances are not primarily formed to overcome market failure. Secondly, alliances are increasingly formed to achieve horizontal integration, and not only vertical integration. Third, alliance activities are no longer a phenomenon related to certain countries and regions, but are representative of most advanced industrialized regions and countries. Fourth, an increasing number of alliances are formed to protect or enhance technological assets of the companies.

Furthermore, the special case of R&D alliances seem to be more oriented towards the accomplishment of specific tasks than traditional alliances (where long-term aspects of business linking were in focus: Porter and Fuller, 1986) and were, therefore, often shorter and more defined in time. In addition, R&D alliances of today show a wider and less systematic range of companies with different sizes that undertake them. Finally, past alliance relationships were often undertaken at an “arm’s length distance” in order to protect oneself in the relationship (Narula and Duysters, 2004). This is obviously not an alternative when it comes to innovating and knowledge sharing in R&D collaborations. Figure 4 presents, as a complement to Figure 3, the development trend of non-equity alliances versus equity alliances between 1960 and 1998.

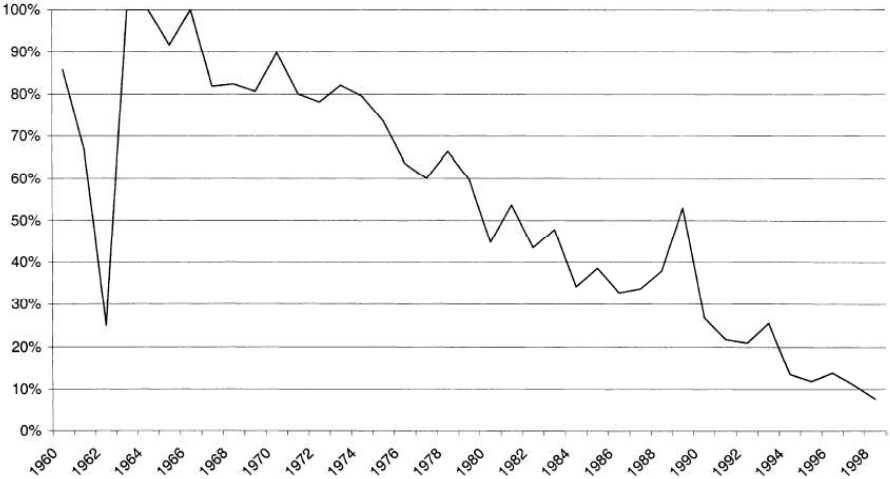


Figure 4. Share of joint ventures in all newly established R&D partnerships (1960-1998). Source: Hagedoorn (2002).

The interpretation of Figure 4 should not be that the number of joint ventures has decreased. Instead, if the data in Figure 4 is combined with the data of Figure 3, the conclusion is that the number of joint ventures has been next to constant (at a level of approximately 100 per year since the early 80s until 1998), while the number of non-equity alliances has steadily increased. One explanation for this trend is that the agreements are becoming more and more strategic, often based on soft assets in fast changing environments and, therefore, the legally more complex equity-based alliance is less attractive or simply not an option. Another explanation is related to learning. As firms become more experienced in dealing with inter-firm collaboration, they are willing to increase the risks associated with a decrease in ownership control in favor of increased flexibility and time to market speed of the non-equity agreements (Narula and Duysters, 2004).

From a strategic perspective, most studies on the alliance phenomenon are conducted to answer whether it is a good strategy or economically beneficially to form alliances, regardless of whether they concern market, production, R&D or other types of alliances (e.g. Gulati, 1998). This wide body of research still represents a great knowledge of the conditions that lead to alliance formation, the strategic options to alliances, as well as the structural properties of different types of governance of alliance operations. Additionally, this research does not only provide useful knowledge about conditions leading to the formation of alliances, it should also be seen as representing conditions that must sometimes be valued against direct managerial issues in different alliance trade-off situations. As an example, a pre-alliance management task may be to choose between a slightly more favorable strategic positioning, (choosing one partner) and a slightly better cultural fit (choosing another alliance partner) – the latter with a proposed direct positive influence on the day-to-day management of the alliance operations.

Although this literature offers valuable knowledge and insights about conditions in the formation of the alliance and how to choose an alliance structure effectively, several recent studies point at the fact that alliances still have a very high failure rate (e.g. Dyer *et al.*, 2004). From such a perspective, Gulati (1998) for example claims that the focus in alliance research on strategic “why” questions has led to an avoidance of the “how” question and also the conditions under which various behavioral and performance outcomes are expected.

THE ALLIANCE WORK SYSTEM AND ITS EFFECTS ON THE INDIVIDUAL

Reviewing management research on alliances reveals several topics with potential important knowledge regarding alliance operational work. A few examples are: the alliance formation process (e.g. Eisenhardt and Schoonhoven, 1996 Gulati, 1999; Doz *et al.*, 2000) success and failure factors in alliances management (e.g. Litter *et al.*, 1995; Doz and Hamel, 1998; Sivadas and Dwyer, 2000); as well as studies focusing on specific aspects related to the alliance operation, such as knowledge transfer and learning (e.g. Anand and Khanna, 2000; Karle *et al.*, 2000; Inkpen, 2000), structural determinants of alliance performance (e.g. Hennart and Zeng, 2005) and trust and commitment in alliances (e.g. Das and Teng, 1998; Krishnan *et al.*, 2006).

Although these studies have offered important knowledge about the management of alliances - such as refined theoretical models of joint-venture design (Hennart and Zeng, 2005) or firm specific learning-based concepts (Inkpen, 2000) - there is a lack of closeness to the subject and the operational reality of specific types of alliances (e.g. Contractor, 2005). Instead, alliances, including R&D alliances, are often empirically studied with a narrow focus on a specific topic using surveys or database sources. For example, Anand and Khanna (2000) test hypothesis on effects of inter-firm learning based on a data set of over 2000 joint ventures; Krishnan *et al.* (2006) examine the relationship between trust and performance on data from 126 international alliances. Furthermore, studies that specifically cover R&D alliances are often conducted to highlight and analyze strategic issues (e.g. risk of losing competitive advantages due to spillover of strategic, product related resources and knowledge). Studies that cover R&D alliances from a perspective of understanding specific work practice in the alliance setting are particularly rare (Gerwin and Ferris, 2004).

The most important stream of alliance research related to the purpose of this thesis is the process-oriented. In particular, research that adopts a dynamic view of the alliance process taking into account the interplay between activities, people, and process is an area that has contributed with specific knowledge on how to understand the alliance work system (Ring and Van de Ven, 1994; Doz, 1996; Ariño and de la Torre, 1998; Kumar and Nti, 1998; Das and Teng, 2002). Furthermore, in the dynamic conceptualization of the alliance process, inter-personal trust is a central component (e.g. Ring and Van de Ven, 1994). Inter-personal trust is also recognized as an important resource for the individual in order for work systems to become sustainable (Moldaschl, 2002). Alliance research related to inter-personal trust is, therefore, also considered to be particular important in this theoretical framing.

Thus, in order to approach operational work in R&D alliance, two areas of research will be presented in detail. The first takes a dynamic view of the alliance process. The second is related to trust that takes conditions of work into consideration.

Process-oriented Research on Alliances

Process-oriented perspectives on the alliance relationship emerge from research covering different stages in the alliance life cycle (e.g. Spekman *et al.*, 1998). In a review on alliance management research, Spekman *et al.* (1998) summarize the linear process view of the alliance life cycle in seven discrete stages of key managerial activities (see Figure 5).

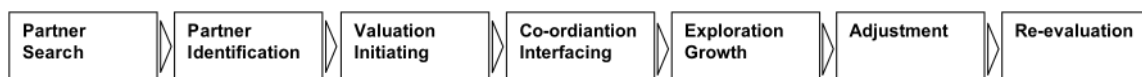


Figure 5. Various stages in the alliance life cycle. Source: Spekman *et al.* (1998).

However, describing the alliance life cycle by a number of discrete stages could be questioned. First, such a view postulates that the transition from one stage to another could be precisely marked and that the stages do not overlap. Secondly, a pre-planned stage-gated model could neglect the complexity of an alliance relationship by not taking the dynamic interplay of activities, people, and process into account. An issue that Harrigan (1985) has already suggested by saying there are significant consequences on alliance performance from relationship-related evolutionary paths.

A stronger conceptualization from this point of view is the dynamic process approach: for example, described in terms of evolutionary cycles, which aims to capture the interplay between activities, people, and process (Ring and Van de Ven, 1994; Doz, 1996; Ariño and de la Torre, 1998; Kumar and Nti, 1998; Das and Teng, 2002).

One of the most recognized and robust conceptual dynamic models is the developmental process model that Ring and Van de Ven (1994) presents. Consequently, this theoretical model has served as a foundation in both theoretical (e.g. Kumar and Nti, 1998) and empirical (Doz, 1996; Ariño and de la Torre, 1998) refinement of the dynamic alliance process in later contributions to this research. Therefore, based on the impact that this theoretical model has had on alliance research as well as being a central conceptualization in this thesis, a short review of Ring and Van de Ven's developmental process model is given.

An important prerequisite in the dynamic process model is that the partners cannot fully control the investments that they make in their inter-organizational relationships (e.g. an R&D alliance). Hence, the relationship is dependent on formal contract and initial structure as well as informal contracts and the ongoing restructuring of the collaboration. That is to say, the agents within the organizations will continuously negotiate, execute, and modify the terms of the cooperation that will change and cover new governance structures for the relationship. Ring and Van de Ven introduce four concepts related to the starting conditions of an alliance in their theoretical framing of the model. These are seen as particularly important for the social-psychosocial understanding of the alliance relationship and must, therefore, be carefully managed due to shortcomings of the formal agreements. The four concepts are summarized in Table 2:

Table 2. Key Concepts in Cooperative IORs. Source: Adapted from Ring and Van de Ven (1994)

<p>Uncertainty</p> <p>Uncertainty in cooperative IORs come from investments into a cooperation that cannot be fully specified or controlled prior to the execution. From this situation, IOR managers will face two types of risks: (i) uncertainty regarding future state of nature (e.g., Perry, 1989) and (ii) uncertainty whether the partners will be able to rely on trust as a counter to the problems of adverse selection and moral hazard (Akerlof, 1970). Furthermore, there are two types of trust related to these risks that can be found in management literature: (i) a business risk view based on confidence in the predictability of one's expectations (e.g. Zucker, 1986) and (ii) a view based on confidence in another's goodwill (Ring and Van de Ven, 1992).</p>	<p>Efficiency and Equity</p> <p>Researchers use efficiency to define the most expeditious and least costly government structure when making a transaction. Although, it could be argued that for assessing a cooperative IOR equity, defined as "fair dealing", is just as important. In fair dealing, reciprocity is sufficient (Gouldner, 1959); however, equivalence in the quid pro quo is not necessary. Fair rates of exchanges between cost and benefits are sufficient, but equality is not necessary for fair dealing (Blau, 1964). In addition, fair dealing implies that the parts receive benefits proportional to their investments (Homans, 1961). Also, fair dealing goes beyond the economic rational calculation of "equivalence of benefits" (Axelrod, 1984) among parties; it includes sociological meaning of indebtedness: i.e. disproportional initial exchanges between parties result in social norms of obligation among parties for future exchanges (Knoke, 1990).</p>
<p>Internal Resolution of Disputes</p> <p>There are two reasons why endogenous safeguards are important: (i) transaction-specific investments made under conditions of uncertainty make parties maintain the relationship – redeploying the assets committed to the cooperation would be inefficient; (ii) in the temporal development of the cooperation social-psychological processes, e.g. psychological contracts among parties will create a pressure to preserve the relationship. In some cases, these safeguards can be codified into formal legal contracts. However, if the relationship is strong with a high level of trust, they will take the shape of psychological contracts (Helper and Levine, 1992).</p>	<p>Role Relationships</p> <p>The role relationship highlights the fact that the individuals actions within the cooperation will be a function of their organizational role and that the role relationship will not be identical to their interpersonal relationships. Guitot (1977) argues that the way individuals make attributions about others' intentions and behaviors will vary significantly if the other is viewed as acting within a "role" as opposed to "qua persona". This, in turn, can be used as an argument for using a combination of formal contracts and trust – hence, individuals rely on trust in their "qua persona" relationships and may not be able to do so when acting as agents within an organization.</p>

The framework presented in Table 2 articulates some of the most important socio-psychological issues in alliances relationships. These issues are particularly important in understanding the work on the individual level and what effects it might have on people in, for example, R&D alliances.

Given the aforementioned conditions, dynamics in Ring and Van de Ven's process model of inter-organizational relationships are then viewed as an on-going and repetitive sequence, going through three main stages: negotiation-commitment-execution – all assessed in terms of efficiency and equity (see Figure 6). Based on this three-staged cycle,

the evolution of the relationship is explained through its emergence, evolution, and dissolution.

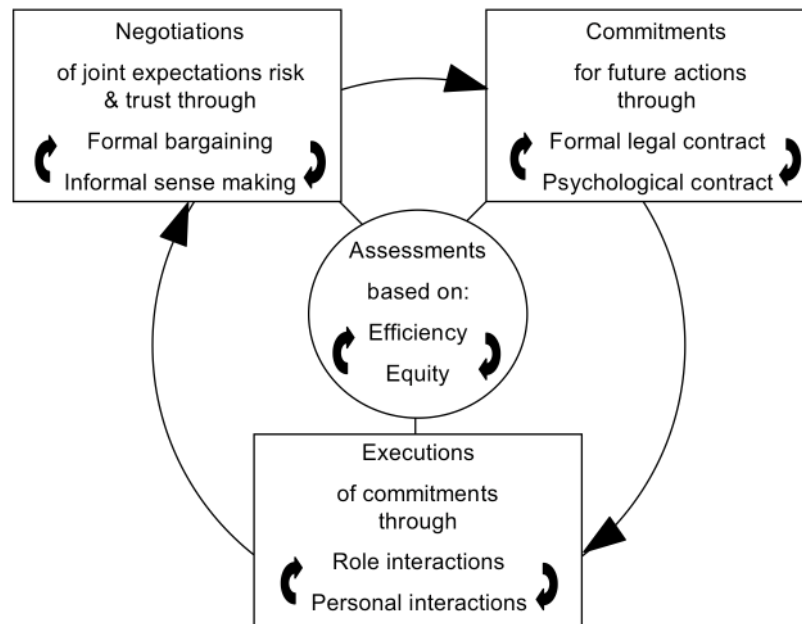


Figure 6. Process framework of the development of cooperative IORs. Source: Ring and Van de Ven (1994).

However, there are several informal social-psychological processes related to this sequence, which change and evolve with the evolution of the relationship that are also dependent of the concepts described in Table 2. These processes explain how and why an alliance relationship proceeds through its life cycle of emergence, evolution and dissolution.

According to Ring and Van de Ven, during the first emerging stage of an alliance relationship, sense-making (Weick, 1995) and bounding processes are important in order to achieve conformance of purpose and expectations. Furthermore, this stage of the process also results in psychological contracts (Argyris, 1960; Schein, 1978), consisting of unwritten expectations and assumptions about each other's rights and obligations. In the evolution stage, institutionalization of the relationship then begins. This is described as a socialization process that transforms an instrumental transaction to a socially embedded relationship by filling it with norms and values, which allow it to be reproduced and sustained. Personal relationships start to supplement role relationships; psychological contracts supplement formal legal contracts; and, formal agreements more and more resemble informal understandings and commitments. In the last stage, Ring and Van de Ven describe scenarios that lead to the dissolution of the relationship. One is that individuals who do not feel included, do not experience predictability in the response to others or do not feel secure in that things are as they appear, can damage the level of motivation and commitment to the relationship. Another scenario is when the balance between informal and formal processes is disturbed (i.e. by increased transaction cost from a too formal process or by inefficient "group thinking" from a too informal process). Therefore, the balance between the formal and informal process is important. Ring and Van de Ven argue that this balance is, in turn, highly dependent on trust and the

management of trust. That is, the greater the ability to rely on trust, the lower is the transaction cost. However, taken to its extreme, this could create conditions for the abuse of trust. Hence, the willingness to rely on trust to deal with uncertainty requires systematic attention to the process by which personal relationships emerge between partners. In this way, personal relationships serve to shape the evolving structure of a cooperative relationship –complementing the formal contracts and processes.

Empirical contributions that could refine the dynamic conceptualization of the alliance process and increase our understanding of the alliance relationship from this perspective have frequently been called for since Ring and Van de Ven's (1994) model is theoretically founded (e.g. Ring and Van de Ven, 1994; Gulati, 1998; Salk, 2005). However, as Salk (2005) notices, publications in this area are limited. In fact, two studies that were published a few years after the publication of Ring and Van de Ven's model appear to remain the most comprehensive empirical contribution to the dynamic view of the alliance process. These are the case studies that Doz (1996) and Ariño and de la Torre (1998) have conducted.

Doz (1996) investigated learning in a set of R&D alliances along several dimensions (environment, task, process, skills, and goals). An important result from his study is that initial conditions could either “imprint” alliance processes (making them negatively inertial) or that they could help generate alliance processes to be evolutionary and adaptive. Negative examples of “imprint” are given where initially separated work in one alliance lead to a situation where partners were unable to adjust work routines and step into new roles later on when the joint work become more complex. In contrast, supporting the alliance success are examples of individuals (referred to as Champions) who were committed to the alliance, who possessed resources to break free from their organization's work routines and prescribed roles and who were, therefore, able to overcome hurdles in the projects. Hence, re-assessment of alliance task, environment, structures and routines, as well as processes, is seen as important factors for alliance success.

Ariño and de la Torre (1998) combine the work by Ring and Van de Ven (1994) and Doz (1996) in a longitudinal case study, suggesting a model of evolution of collaborative ventures. The focus of their study was on the description of circumstances and situations in the alliance process where the relationship quality could be led into either positive or negative “spirals”. By using events as the unit of analysis, the authors were able to identify specific actions and reactions in these situations. The results show how the partners, as a consequence of these events, either had to renegotiate the terms of contract or modify their behavior in order to restore the balance in the relationship. Furthermore, several scholars have pointed to the use of events as a unit of analysis as being a particular effective methodological approach in order to understand the dynamic alliance process (Ring and Van de Ven, 1994; Kumar and Nti, 1998). The results from Ariño and de la Torre (1998) study underline this.

In addition, both of these empirical studies acknowledge the organizational embeddedness of an alliance and its influence on the process (Doz, 1996; Ariño de la Torre, 1998). Embeddedness means that an alliance is not an isolated dyadic relation, but an operation embedded within two (or more) organizations, cultures, practices, and processes that can be assumed to influence the alliance work and its process. Results from both studies show that the embedded nature of an alliance has implications for the

management of an alliance process, since specific interactions with one or both of the participating organizations (or other external changes) can change the preconditions for cooperation: for example, through changed views on the efficiency and equity dimensions.

Important aspects to understand the dynamic alliance process are, therefore, the underlying negotiating, commitment, and execution cycles in the alliance process, as well as the importance of specific events or critical incidents in this process. From the dynamic process perspective, the alliance work systems will undoubtedly offer a high degree of complexity and uncertainty for the individual. However, in all of the aforementioned studies, relational quality and trust are established as important resources for the individual in order to overcome challenges related to the less formalized and uncertain realities in this type of work.

The Concept of Trust in the Alliance Relationship

Several researchers have recognized the concept of trust as necessary for the understanding the behavioral aspects in alliance relationships (e.g. Ring and Van de Ven, 1994; Parkhe, 1998a,b). A brief overview of the concept of trust in relation to the alliance work system will, thus, be given.

There seems to be no uniform definition of trust in a research context (Geyskens *et al.*, 1998). However, as shown in Table 2, Ring and Van de Ven (1994) distinguish between two types of definitions of trust: the first type is based on the confidence or predictability in one's expectations, incorporating the definition applied here and also the one Zucker (1986) uses; the second is based on the confidence in another's goodwill (Ring and Van de Ven, 1992).

The definition following that of Boon and Holmes (1991, p. 194) will be applied: "A state involving confident positive expectations about another's motives with respect to oneself in situations entailing risk". In a review of trust literature, Mishra (1996) identifies four dimensions of trust: competence, openness, concern, and reliability. Therefore, the definition of Boon and Holmes (1991) will be supplemented by covering the four dimensions that Mishra (1996) suggests.

The relationship between trust and distrust in a management perspective is not direct in the sense that the violation of expected behavior creates distrust. Although violation of trust creates confusion, it does not automatically create distrust (Zucker, 1986). Instead, distrust presumes a suspicion of intentional violation of the relation. In the case of an alliance, Parkhe (1998a) sees trust as a psychological, sociological, and economic phenomenon. That is, trust resides within individuals and is, therefore, psychological. Individuals would have no occasion or need for trust apart from social relations; therefore, trust is sociological. In alliances, firms' tangible and intangible assets are at stake; therefore, trust is economical. For example, due to the risk of divergences in goals between the partners, the economic part could be expected to be more present and more critical in alliance relationships than within organizations. Furthermore, the influence of trust is likely to vary with the context of specific alliances: i.e. industry sector, strategic goals of the alliance partners, and the structure of the cooperative agreement, etc. (Parkhe, 1998a; Osborne and Hagedoorn, 1997).

As we have previously indicated, there is an extensive base of literature that covers numerous aspects of trust in different alliance situations. For example, issues such as reduced transaction costs due to the presence of trust (e.g. Nooteboom, 1996), inter-firm trust as a source of competitive advantage (e.g. Barney and Hansen, 1994), and trust as a mediating role of knowledge transfer (e.g. Inkpen and Tsang, 2005; Kale, Singh and Perlmutter, 2000) have all been addressed. In a broader perspective of inter-organizational relations, trust has also been seen as a factor related to performance or success (e.g. Gambetta, 1988; Zucker, 1986; Kumar, 1996; Powell, 1996; Krishnan *et al.*, 2006).

Despite, the large amount of research and the interest in how trust affects the success of an alliance, there are still few studies that examine the role trust plays in the daily operative work in specific types of alliances (Ring and Van de Ven, 1994; Gulati, 1998; Ring, 2000; Planander, 2002).

However, if efforts to build trust in an alliance are to be effective the micro dynamics of trust and how trust is created must be explicit to those involved in the alliance project. In the following, a model based on the work by Zucker (1986) and Parkhe (1998b) is presented that describes the building of trust between organizations on the operational level. The model is built on three mechanisms for trust production: process-based, characteristic-based, and institutional-based mechanisms (Zucker, 1986). First, process-based formation relates to the consistency of behavior over time. To act consistently is likely to create expectations of predictability. Moreover, if the parties expect a mutually beneficial future, this will further strengthen the sense of trustworthiness. Process-based trust formation is, therefore, simultaneously “backward looking” (reassurance of past history) and “forward looking” (expectations of a promising future). Secondly, characteristic-based trust relates to specific attributes among the partners (e.g. cultural and social). Dissimilarities in these aspects will negatively influence the perceived trustworthiness if they reduce predictability (e.g. through differences in assumptions and expectations). Finally, the concept of institutional-based trust refers to the building of trust through formal mechanisms in the alliance contract (e.g. alliance specific investments, built-in incentives, or punishments for cheating). This last basis for trust formation could serve as an important tool when history and character of partners are not known or when the future is changing fast. To some degree, each of these mechanisms for trust formation is in the hands of management and are, therefore, an important managerial tool in alliances. Managerial actions, developed from the work of Parkhe (1998b) and Zucker (1986), which are linked to how these mechanisms could be used to proactively manage trust in the R&D alliance work system, are presented in Table 3:

Table 3. Managerial Actions Related to Bases of Trust-Building. Adopted from: Parkhe (1998b) and Zucker (1986)

Trust Formation Mechanism	Description	Managerial Actions Related to the Three Mechanisms of Trust Formation in Alliances
Process-based	Consistency of behavior and actions over the alliance timeline increases the possibility of trust formation (and vice-versa)	(i) Match expected behavior with actual behavior – consistent behavior that matches expected behavior tends to build trust. (ii) Use well functioning, and multiple, communication channels to increase action taking and transparency between partners. (iii) Plan with a perspective of endurance – based upon a common time-horizon. (iv) Change own behavior before expecting partners to change theirs. (v) Act and plan in advance. as well as work constructively, to make life easy for all parties. (vi) Divide large and complex issues into smaller ones, then execute them in sequence. (vii) Be aware of the asymmetry between positive and negative experiences: to avoid negative surprises and to repeat positive actions.
Characteristic-based	Differences in cultural and social characteristics decrease the possibility of trust formation (and vice-versa)	(i) Be aware of the fact that significant differences in social and cultural backgrounds limit the ability to communicate and the mutual understanding between the partners; in turn, this obstructs trust-building through, for example, non-existing homogenous expectations and assumptions. (ii) Avoid situations leading to cultural shock and promote cultural empathy. (iii) Use training and education programs to increase awareness and to overcome such differences. (iv) Be aware of the power that comes with conquering social and cultural differences; if successfully managed, these situations can result in high levels of trust between partners.
Institutional-based	Formal trust formation mechanisms to increase trust formation	(i) Make non-recoverable alliance specific investments. (ii) Build in direct punishments that reduce the benefits of opportunistic behavior or include direct gains from increased cooperation and integration in the contracts between the partners. (iii) Involve an independent certified body (future method) to define and qualify the trustworthiness of one's own firm.

Parkhe (1998b) stresses five features of ongoing alliance management, as a consequence of these trust-building mechanisms. First of all, managers should keep track of the alliance timeline in order to reflect on the – mostly process-related – trust-building sources in the relationship. Secondly, manage the alliance with trust-building speed in mind, if possible. Although varying from industry to industry, it is important to start in small steps and not “over-speed” the pace of trust building. Third, watch out for divergence of partner’s strategic directions. The possibility for such a divergence could be obvious from the first day in some alliances; in others, however, it could appear after several years – then it is often much harder to predict and manage. Fourth, also watch out for asymmetry in value creation or in value appropriation. Adjustments due to fairness are often necessary to build trust over time, especially between partners that are unequal in power. Finally, staffing issues are critical in alliance relationships. Although highly attractive for most positions in organizations, Parkhe (1998b) claims that key personnel with diplomatic skills, integrity, and power of initiative should be prioritized in alliance projects.

No doubt, both the building of trust in the alliance relationship and other challenges related to the dynamic view of the alliance process make alliance management a complex and demanding task. However, if the formation of trust is successful it seems to be a particularly important prerequisite in alliances - both for performance and in terms of practical support for the individual. When concluding the literature review related to the alliance work system, it is rather unexpected that the development of role prescriptions for the operational alliance leader has not been adequately addressed in the alliance literature. This has also been recognized, for example, by Spekman *et al.* (1998) and Ring (2000).

However, although Doz's (1996) study provides some specific knowledge regarding product development work in the alliance operation (such as the difficulties in adjusting work routines and stepping into new roles as the result of separated work in the initial part of the collaboration). Such results and what the consequences are for the individual are limited. The next section will, therefore, address operational aspects of product development work that are related to the purpose of this thesis, based on product development literature in general.

THE PRODUCT DEVELOPMENT WORK SYSTEM AND ITS EFFECTS ON THE INDIVIDUAL

Research on product development and innovation is extensive and diversified. Several review articles in the general area of product development paint this picture (see, for example, Brown and Eisenhardt, 1995; Griffin and Hauser, 1996; Krishnan and Ulrich, 2001). These articles show a large variation of theoretical perspectives and disciplines: such as business strategy, organizational theory, organizational behavior, marketing, operation management, etc. (Krishnan and Ulrich, 2001).

Process and Integrated Perspectives on Product Development

The product development process is a central concept when describing the product development operation (Cooper, 1993; Ullman, 2003; Ulrich and Eppinger, 2003). The basic aim of this process is to coordinate activities in and between functions in the firm that are related to, for example, the time schedule of the firm's production and market introductions – all in order to finally put the right product on the market at the right time and with the right quality (e.g. Wheelwright and Clark, 1992).

Although, in practice, most of these process models have some company specific perspectives or focuses, the basic structure of process timeline and control gates is prevalent. Neither the basic features differ much between the models that are described in the literature (e.g. Engwall, 2003a). In Figure 7, one of the most recognized stage-gated product development process models is depicted (Cooper, 1993).

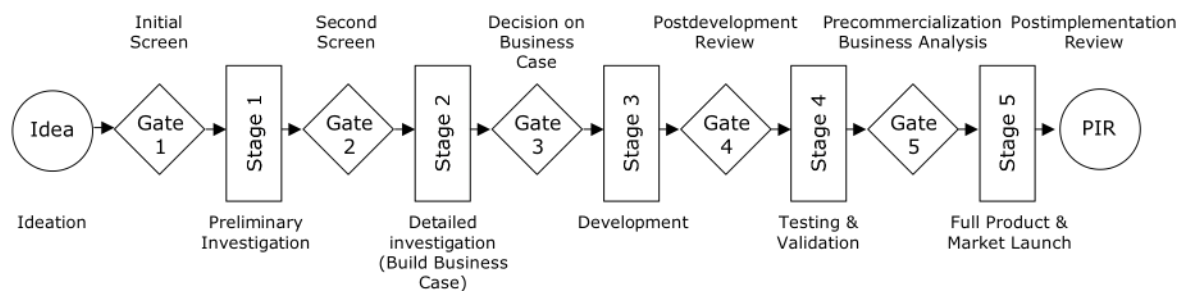


Figure 7. Generic stage-gate Process model. Source: Cooper (1993).

Process models have proven to be important instruments in industrial practice for companies to coordinate their product development recourses, evaluation performance, and to reach their strategic objectives (Cooper, 1993; Wheelwright and Clark, 1992). Particular strengths of the stage-gate model include: it is straightforward and easy to view, it creates control and supports decision making, and it creates legitimacy – for example, by describing tenantable aspects of uncertain projects (e.g. Engwall, 2003b).

However, this way of looking at the process (i.e. based on a hierarchy of design decisions to execute the predefined product specifications where the process effectiveness is evaluated in terms of number of engineering changes) has become more and more questioned with an increased emphasis on innovation and flexibility (MacCormack *et al.*, 2001; Engwall, 2003b; Olin and Shani, 2003). Although, Engwall (2003b), for example, claims that the problem is not the stage-gated model. Instead, he questions the logic of formulating and freezing the goal of the project in the beginning of the process. Innovation and flexibility could be increased if one allows for learning through the process by separating fixed goals from the actions.

Demands on the product development operation discussed in the literature, such as the need for innovation and flexibility, mostly derive from two critical objectives that a firm must meet: maximizing the fit with customer needs and minimizing time to market (e.g. Schilling and Hill, 1998). With a less direct focus on the product development process, there are a number of approaches in the literature that relate to how a firm should manage these two conflicting objectives: one such stream is integrated product development, where researchers have focused on integrating mechanisms in the interface between different units that are involved in the development and launch of a new product (e.g. Norell, 1992; Gerwin and Barrowman, 2002). This approach has acknowledged that the product performance is positively related to the integration of different functions involved in the whole of the new product development process: both between the different disciplinary functions within the product development function as well as between, for example, the marketing and the product development function (Griffin and Hauser, 1996; Adamsson, 2007). A related approach to integrated product development is concurrent engineering (Sage, 1992). The aim here is to reduce the lead-time of the development process by concurrently implementing different stages in, for example, development and production with support of relevant managerial tools and information systems (e.g. Norell, 1992). Furthermore, the approach of systems engineering is primarily related to large and complex product and system projects. This domain of research focuses on architectural design and integrates elements of systems modeling and simulation, decision analysis, requirement management, etc. (Stevens *et al.*, 1998). Finally, the concept of lean has also been applied on the product development operation. Lean product development is an integrated approach on product development that emphasizes collaborative aspects, such as early and deep involvement of suppliers, cross-functional teams, and strategic management – founded on the Japanese lean managerial philosophy (e.g. Karlsson and Åhlström, 1996).

However, management approaches and process models related to product development also have limitations. According to Brown and Duguid (1991), conceptual models and methods of work in general often show large discrepancies compared to how work tasks are practically executed. Moreover, Engwall *et al.* (2005) identifies no less than five different ways that project managers perceived and used product development process models, thus, suggesting that, in practice, these models were more of a support for cognitive rather than behavior standardization. Hence, such schematic product development models (which are used and viewed differently when it comes to purpose and practical use) runs the risk of being more similar on paper than in reflecting the operative work of product development. Clearly, such discrepancies between models and anticipated work reality could become problematic, particularly if these models are used as tools in coordinating inter-organizational work where the partners may have to rely

more on such models due to a lack of experience in each other's work practices. Specifically related to the individual level, Engwall *et al.* (2005) also question the ability of these models in order to function as a support for the individual in a less formalized, post-bureaucratic setting. If people within the organization interpret these models differently, then they will not give consequent guiding for the individual in executing tasks.

The specific interest of this thesis is to explore individual sustainability in R&D alliances. In contrast to the extensive attention on managerial approaches in the context of product development, the emerging concept of sustainability has just started to be developed (Shani and Sena, 2002; Olin and Shani, 2003). Olin and Shani (2003, p1.), by referring to Docherty *et al.* (2002), view sustainability in the specific case of new product development as "the organizational ability to continuously regenerate resources, improve quality of work life, achieve a high degree of system flexibility that allows for continuous change and development of human, technological and work processes, and to improve business process and outcome".

However, Lewis *et al.* (2002) have characterized product development as "an intensive work". Work intensity on the individual level refers to an imbalance between an individual's resources and work demands that eventually, if not corrected, will lead to non-regenerative consumption of human resources (Docherty *et al.*, 2002a; Olin and Shani, 2003). Shani and Sena (2002, p89.) view intensity "...as a socially constructed phenomenon that is embedded in the increasing rate of change in the nature of new product development work."

Therefore, when introducing new managerial approaches in order to meet environmental and technological challenges, consequences from these new approaches on human resources should be considered in order to achieve both business performance and sustainability.

In a case study of a new product development project, adopting a flexible process approach, Olin and Shani (2003) explores sustainability. The project was characterized as a process with overlapping phases that focus on actively postponing the final decisions of design configurations in order to promote learning during the development process, as well as the exchange of ideas in and between organizational units. Based on a framework founded in sociotechnical system theory, strategic management, and resource-based theory, the authors describe positive results of creation of actionable knowledge: design for flexibility in product development units related to sustainability in new product development work. Examples of new and flexible work practices, such as mock-up models to share early conceptualizations and create actionable knowledge, were found to be important for sustainability. As such, the authors also stress that adapting to new flexible approaches will have an impact on social subsystems, including the profile of engineers and their competences. Although, a comprehensive guiding framework taking new flexible approaches and sustainability into account has yet to be developed (Olin and Shani, 2003)

These results highlight that, in order to support sustainability, new managerial approaches promoting integration and flexibility in product development, should take work practice in to consideration.

Work and Practice-Centered Perspectives on Product Development

Since an understanding of demands made on human resources is a key in achieving sustainable work systems in product development, literature including individual requirements and competences related to flexible work practices will be reviewed. The framing is based on three organizational principles that support integration and innovation in product development work, as suggested by Dougherty (1992a, p. 87).

- (1) A redefinition of individuals' roles and responsibilities in terms of a realistic yet holistic sense of tasks.
- (2) A reconception of work as a social and collaborative process.
- (3) A revision of strategy as an ongoing process which specifies clear, succinct goals, articulates them across the organization, and revises them

These principles are assumed to contribute to sustainability in product development through two ways: (1) enhancing business performance (e.g. by supporting new flexible approaches) and (2) regeneration of human resources by reducing work intensity. These principles, by being practice centered, are seen as reducing work intensity by promoting resources for individuals to handle tasks in flexible work systems and uncertain work environments. For example, if implemented to support individuals in the product development work, these principles could reduce the gap between the formal process models and the reality of work, support understanding a more complete picture of the work system, and acknowledging the need for more "soft" skills in these types of work (Dougherty, 1992a,b; Dougherty and Corse, 1995). Moreover, the use of principles - and not rules - is particularly important when designing sustainable work systems. In order to eliminate the mismatch between an individual's resources and demands from work, principles that acknowledge an understanding of the underlying fundamentals in the design of specific jobs is important, which may not be the case by using predetermined rules (Heckscher, 1994; Kira, 2003).

Roles and Responsibilities

A role is referred to as patterns of behavior expected by others from a person holding a position in an organization or a team (e.g. Huczynski and Buchanan, 2007; Bratton *et al.*, 2007). According to Dougherty (1992a), peoples' roles should not be "abstracted" from the overall tasks of the company; instead, they have to be more comprehensive in order to fit with the practice of product innovation (as already acknowledged by Burns and Stalker, 1961). This will allow commitment to, and responsibility for, the whole product effort (not only a segmented portion). This, however, needs to be supported by an encouragement of people to adopt new roles. The employee needs skills to manage such new challenges in order to be able to broaden the role, as well as to handle new types of interactions (e.g. with customers or departments with different competences). These aspects regard both specialized engineers and operative leaders, although the main focus on roles in innovation has been on operational leaders.

Leadership roles, however, have a long tradition in innovation and product development literature (for a review see, for example, Elkins and Keller, 2003). The role of the project leader is one of the most recognized in earlier research. In general, this role has been described in terms of administrative activities such as planning, control, and coordinating. This role mirrors the linear approach of the product development process by having an

administrative profile; although more recent research also acknowledge the project leader role in relation to, for example, group processes and team building. However, Elkins and Keller (2003), for example, recognize the need for a better understanding of the multiple roles of the project leader expected in relation to integrated approaches on product development (e.g. including external boundary-spanning actions, etc.). Another established role is that of Champion (Schon, 1963), which is described as a single person recognizing, proposing, pushing, and demonstrating a new technical idea or procedure (his/her own or that of someone else) (e.g. Roberts and Fusfield, 1982). The Champion's behavior has been shown to have a positive influence on new product innovation in recent studies (Howell *et al.*, 2005). However, some authors have questioned the role of Champion in external relationships due to the challenge of influencing personnel and systems in two organizations (Bidault and Cummings, 1994; Sivadas and Dwyer, 2000). In contrast, Doz (1996) points to how specific individuals broke rules and working procedures in order to overcome hurdles; he labeled those individuals Champions. Also, the Gatekeeper is a well-accepted and distinct role in innovation (Allen and Cohen, 1969, Allen, 1971). A Gatekeeper is a person who occupies a key position in an informal communication network (i.e. a person to whom others most frequently turn for technical advice and consultation, and who has more contacts with technical activities outside the organization). The importance for innovation of the informal network of individuals, including gatekeeping and boundary-spanning behavior, has been confirmed in later studies (e.g. Allen *et al.*, 2007). Although communication and networks are important aspects of new approaches in product development, this role has not been systematically studied in relation to open innovation or R&D alliances (Gemünden *et al.*, 2007; Knudsen and Nielsen, 2008). In addition, important research regarding roles has also been conducted with a specific focus on teams, such as the classification of Ancona and Caldwell (1992a) of teams' boundary-spanning roles and Belbin's (1981/2003) work on informal roles in management teams.

Moreover, the development of extended roles and abilities to take on more responsibilities require joint efforts between product development and human resource functions, in terms of both in on-the-job and off-the-job training (Boxall and Purcell, 2008). As such, Dougherty (1992a) suggests a system of continued formal training, sabbaticals, etc. along with the encouragement to develop more than one area of core competences. In addition, Dougherty (1992a) acknowledges the need for a completely new psychological contract between the person and the firm. The broader roles and responsibilities (contributing to the overall product success) should be met by replacing of narrow individual jobs with an appreciation of workers as professionals who control the daily execution of their work. In these areas, the human resource management system must support the suggested development of skills and experiences – aligned with new rewards. As a result, careers should also be based more on breadth and depth rather than climbing the hierarchy (e.g. Schuler and Jackson, 1999).

Work as Collaboration

Effective collaboration across departments has long been claimed to be an important means for successful product development and innovation (e.g. Dougherty, 1992b; Griffin and Hauser, 1996; Kahn, 1996). Communication is one thoroughly investigated aspect related to collaboration (e.g. Allen, 1971; Katz and Tushman, 1981). For example, Ancona and Caldwell (1992a) found that not *how much*, but rather *how*, teams communicate

externally had influence on their effectiveness. Effective teams engaged in both political and task-oriented external communication from which they could capitalize in their work. Moreover, Ancona and Caldwell (1992b) saw that external communication occurred more frequent if the other party had a similar functional background. This indicates positive effects on external communication from representation of multiple functional competences in a team. In terms of barriers for communication, Dougherty (1992b) suggests that functions develop different “thought worlds”, related to the function’s pool of knowledge (what members know) as well as systems of meaning (how members know). Hence, identical information can lead to different interpretations in different functions, and also results in unique insights. Mutual adoption between people has been shown to create vital innovation knowledge over time (e.g. Mintzberg and McHugh, 1985; Leonard-Barton, 1988). Such positive effects from combining insights of different specialized functions underline why communication and collaboration are critical in product development work. However, the practice of how functions combine their knowledge and insights in work also influences product success. According to a study by Dougherty (1990), highly interactive and iterative manners in cross-functional combination of perspectives, characterizes work practices that lead to successful products. In contrast, work practices with sequential shifts in focus - where certain phases were overshadowed by a particular specialized function’s perspective - were related to failed products. Furthermore, teams engaged in concrete tasks with others and worked outside routines and traditional relationships were able to overcome cross-functional barriers (Dougherty, 1992b). Olin and Shani (2003), in line with these results, found that specific platforms (such as shared mockup models) resulted in task-oriented collaborations and the creation of actionable knowledge. This contributed to shared knowledge and emerging relationships when combined with decentralized control of the product development process.

From a practice-centered perspective on collaboration, Dougherty (1992a) stresses that to spend time together in the early stages of a product development project in order to learn about each other, creates a basis to work quickly and also to work separated in later stages of the project. Such group work could also support the understanding of what the whole work group knows and where the group is headed in their work. Moreover, each person can also understand how their input matters to the project, based on this type of integration: even if they are not involved in the final decisions. However, such collaborative work is built on an understanding of other people in the daily work, which requires collaborative skills. Dougherty (1992a) recognizes three types of practice-centered collaborative skills: first, everyday collaborative skills such as running meetings, listening, leading, and make group decisions; secondly, having an ability to appreciate the perspectives of people in different departments, which may have different “thought worlds” (e.g. regarding products or market needs); third, to be able to anticipate what people in other departments need to know in order for them to carry out their part of the work.

Strategizing for Renewal Through Product Innovation

Strategic planning and rationally planned product development are thoroughly examined areas in research (e.g. Brown and Eisenhardt, 1995). Work systems adopting comprehensive rather than compartmentalized roles, as well as a more widespread use of collaboration, needs clear goals (e.g. Dougherty, 1992a). A coherent statement including

goals and directions based on rich, explicit, and action oriented information enables collaborative teams to conceive their purpose in terms of strategy. Hence, such decentralization of strategic information helps teams and groups in choosing one path out of many possible paths in the innovation work (Schuler and Jackson, 1999). Moreover, in order to be useful on an individual level, the strategy should be related in a realistic way to the operative work of product innovation (e.g. Wheelwright and Clark, 1992). However, as aforementioned, a strong focus on innovation and adoption of integrated, concurrent, and flexible management approaches in product development are, in many senses, contradictory to rational planning and focused strategies (e.g. Dougherty, 1992a; Engwall, 2003a; Olin and Shani, 2003). A process of ongoing formation and development of market and technology knowledge that allows learning throughout the development process is, therefore, more consistent with current challenges in product development work (e.g. Dougherty, 1992a; Engwall, 2003b).

Some practical examples are shown in the aforementioned case study by Olin and Shani (2003). First of all, proper business intelligence information that provided a clear market opportunity was critical. The project utilized this information effectively in order to convince sponsors and to abandon parallel design alternatives. Secondly, a critical activity in the definition phase was the development of a 1:1 mockup draft model developed from all strategic and technical information that showed the final product including proportions, positions, and sizes of all parts. The model was replicated and distributed throughout the project, thus, enabling quick and common understanding of the product and an instant start of the design work. Furthermore, decentralized control over the design process made a *feed-forward* (push) strategy possible (i.e. the receiver in each stage defined the deliveries in order to freeze only the necessary parameters and enable learning, continuous improvements, and flexibility).

The literature on product development work system could be characterized by an increased focus on integrative managerial approaches in order to meet requirements for innovation (both in terms of product and process). These approaches will demand high levels of competence, social abilities and strong commitments on the individual level: both related to problem solving and committing to the goals of the firm. This will give great opportunities for creativity and a pioneering spirit, but could also bring high levels of work intensity. However, there is still little addressed in product development literature about what constitutes these opportunities and risks, and how they affect the regeneration of human resources.

SUSTAINABILITY IN LESS FORMALIZED WORK SYSTEMS

This part of the frame of reference aims to supplement the literature on alliances and product development in relation to how these work systems could be understood to affect individuals on the operational level. In particular, we will address the risks of high work intensity from imbalances between individuals' resources and demands from work that lead to a consumption of human resources.

Imbalances between persons and their work that lead to a consumption of human resources have been a well-known and problematic issue throughout the history of industrial work science (e.g. Brödner and Forslin, 2002). These include physical, cognitive, social, and emotional imbalances. Bureaucratic organizations have received substantial

critique from this perspective (Bennis, 1966; Heckscher and Donnellon, 1994; Heckscher, 1994). Heckscher (1994) argues that the fundamental problem of bureaucratic work systems lies in the fact that “people are only responsible for their own jobs”. According to Heckscher, this leads to a number of consequences. For example, people are not involved and engaged in the operation and development; they are only present. As a result, the true capacity and intelligence of the employees are not used. Initiatives are limited by slotting people into predefined offices. Moreover, the bureaucratic structure represents how the organization is structured and controlled. Therefore, change can only happen through re-structuring; this comes from the top and is often experienced as painful and disruptive for people in the lower parts of the organization. In addition, since decision-making is based on hierarchy (in a top-down fashion), top management’s limited understanding of details on the lowest levels of the organization will prevent an optimal design. Therefore, in the case of bureaucratic organizations, imbalances in work and risks of consumption of human resources derive from the lack of opportunities for the individual (Docherty *et al.*, 2002a).

Rigid, rule-based, and pre-planned bureaucratic organizations not only reduce opportunities for the individual; as has been pointed out in sections related to both alliance and product development work systems, they also fail to be competitive in complex and dynamic business environments (e.g. Dougherty, 1992b; Ring and Van de Ven, 1994; Docherty *et al.*, 2002a).

However, despite the extensive literature regarding these open and flexible approaches adopted in product development in order for companies to become competitive, limited attention has been given to sustainability (e.g. Olin and Shani, 2003).

Instead, literature has more frequently addressed the imbalances between people and their work in less formalized and more flexible work systems, taking a more general view of this transformation of organizations and work systems. These are described in terms of Bureaucracy to post- Bureaucracy, Fordism to post-Fordism, or Taylorism to post-Taylorism, etc. (e.g. Peaucelle, 2000; Williams, 2007).

A group of scholars sketch what they refer to as *the ideal type of post-bureaucratic organizations*, based on changes they witnessed in their research in the seminal work *The Post-Bureaucratic Organization: New Perspectives on Organizational Change* (Heckscher and Donnellon, 1994). These changes are related to new technology, deregulation of industries, global competition, etc. The authors describe a number of empirical developments that have become central to corporate management, which are seen as undermining the foundation of the rigid and rule-based bureaucratic organization (for example: self-managing work teams that have the responsibility of scheduling, disciplining, and ensuring quality; cross-functional teams in managerial and professional ranks; “parallel organizations” that operates on the basis of multilevel consensus, often side-by-side with traditional bureaucracy; concepts and practices that seek to build the decision-making capacity of peer groups; the formation of partnerships between different companies; the importance of negotiated solutions as opposed to solutions determined from above; and new managerial roles, such as task force leaders, change agent, coordinator, boundary-basher, etc). Hence, in contrast to bureaucracy, Heckscher (1994) claims that the “master concept” of the post-bureaucracy is based on “an organization in which everyone takes responsibility for the success of the whole.” Table 4 below

summarizes twelve characteristics of the authors' vision of *the ideal type* of post-bureaucracy.

Table 4. Typical Characteristics of the Ideal Type of Post-bureaucratic Organization. Source: Summarized from Heckscher (1994)

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- I. Consensus is in the post-bureaucracy created through institutionalized dialogue. Consensus is reached in bureaucracies through acquiescence to authority, rules or tradition.
 - II. Influence rather than power defines dialogues. The ability to influence is based on a number of factors, such as knowledge of the issue, commitment to shared goals, and proven past effectiveness.
 - III. Influence initially depends on trust. That is to say, the belief of all members that others seek mutual benefits, rather than to maximize personal gain. The major source of this kind of trust is interdependence (i.e. the understanding that success is coming from combining the performance of all involved). This derives from a clear understanding how different parts of the organization contribute to the overall strategy, specifically in business.
 - IV. There is a strong emphasis on organizational mission due to the interdependence of strategy as the key integrator. Employees need to fully understand the mission and the key objectives in order to make fast decisions based on coordinated actions.
 - V. There is an open sharing of information about corporate strategy and an aim to clarify the connection between individual jobs and the mission of the whole in order to link the individual contributions to the mission. This enables individuals to break free of the boundaries of their "defined" jobs and think creatively and cooperatively about improvements in performance.
 - VI. Guidelines for action must complement the mission. Such guidelines, however, should take the form of principles rather than rules. That is, principles that are more abstract and that express the reasons behind the rules, which are typical for bureaucracy. Hence, individuals are given flexibility and are asked to think about the reasons behind their actions and related constraints, rather than just follow procedures. Intentional and unintentional abuse is the risk related to this system; however, these could be reduced by two mechanisms: the creation of trust and by periodic reviews of the principles.
 - VII. Decision-making processes must continuously be reconstructed because of the fluidity of influence relations by comparison to the bureaucracy. That is, the nature of the problem is deciding "whom to go to" - not the positions of those initially raising it. This also implies the need for "meta-decision-making" processes for *deciding how to decide*.
 - VIII. Relationships are based on "knowing whom to go to" for a specific problem, rather than building a stable network of friendship relations. Therefore, influence relations are wider and more diverse; however, they are also shallower and more specific than in traditional "communities".
 - IX. In order for a system of influence to function, reputations must be possible to verify and make public. Therefore, an unusually thorough and open process of association and peer evaluation must be provided. This provides people with a relatively detailed view of each other's strengths and weaknesses.
 - X. The relatively open boundaries of the post-bureaucratic system have several consequences: that is to say, more tolerance for outsiders coming in and insiders coming out, new career patterns and the growth of alliances and joint ventures among different firms. (For example, large companies that had a long history of "going it alone" now experience an explosive growth in these types of cooperations).
 - XI. Equity in post-bureaucratic systems is problematic due to the increased pressure to recognize the variety of individual performance. In bureaucratic systems, this is based on objectivity and equality of treatment. However, one solution to this situation might be the development of "public standards" from performance.
 - XII. A post-bureaucratic system has a different relation to time than that of the bureaucratic system. The built-in expectations of change in post-bureaucratic systems result in attachments of time frames to actions.
-

Although the ideal type of post-bureaucratic organization is a vision and not a "ready to apply" organizational concept, it does provide a point of reference for challenges that could be expected in less formalized work systems. As such, this and other visualizations, for example, post-Fordism and post-Taylorism, have been important means for understanding opportunities and challenges on the individual level in modern organizations of which Heckscher and Donnellon's (1994) contribution is an important part.

Before addressing such opportunities and challenges for the work in R&D alliances, some general reflections regarding imbalances between people and their work in the post-bureaucratic versus the bureaucratic setting will be given. First, the ideal type of post-bureaucratic organization indicates that something has completely changed. Although major changes have been undertaken over the past decades in our organizations, this is not the same as to say that all prior perspectives and structures have been abandoned. Instead, these are still present and, therefore, still affect modern organizations and work systems to varying degrees (Docherty *et al.*, 2002a). As will be discussed, this could lead to particular contradictories and complex situations in the operational work. Secondly, if compared with the indicated problem in terms of a lack of opportunities in bureaucratic organizations, the described post-bureaucratic organization seems to offer grate chances (e.g. for creativity and initiatives). Unfortunately, modern jobs that seem to offer increased degrees of psychological satisfaction (Thorserud and Emery, 1969), balanced work experiences (Karasek and Theorell, 1990), and personal development and growth (Antonovsky, 1987a,b) are associated with other types of imbalances and problems: for example, resulting in stress and burnout (Docherty *et al.*, 2002a).

Therefore, the next section will discuss work intensity and new types of imbalances that could be a result of work in a post-bureaucratic setting, specifically as they relate to R&D alliances.

Work Intensity in Less Formalized Work Systems

Some risks of imbalances between people and their work in an ideal type of post-bureaucratic organization are indicated in Table 4 above (e.g. new and demanding roles for the individual, openness regarding individual performance, tolerance for outsiders coming into the organization, etc.). In order to create a framework for exploring sustainability in the operational work in R&D alliances through critical incidents, this section focuses on resource consumption and regenerative aspects, respectively. Particular addressed areas are expanded and less defined roles, leadership approaches, conditions for work collaboration, and contradictions with coexisting organizational paradigms. Lastly, we present how “good work” is understood in this research, based on concepts that support regeneration of human resources.

According to the literature, the reality in alliance and product development work matches several of the characteristics of the ideal type of post-bureaucratic work. A few typical examples are the dependence on informal processes and interpersonal relationships in alliances (e.g. Doz, 1996; Ariño and de la Torre, 1998) and decentralized control over the product development process (e.g. Olin and Shani, 2003). Moreover, Dougherty’s (1992a) arguments for the need of broader and more holistic roles for product innovators is well in line with Heckscher’s (1994) statement regarding the *master concept* of the post-bureaucratic organization as being “an organization in which everyone takes responsibility for the success of the whole”. Others agree that this is the main facet of the post-bureaucratic setting (for example, Hirschhorn (1997) specifically acknowledges the increased integration of the person and the job as the most positive aspect of post-bureaucracy). At a first look, this could be interpreted as being only positive. For example, when compared to the demand-control concept of Karasek and Theorell (1990), the post-bureaucratic setting seems to offer several positive aspects that should reduce stress

among individuals (i.e. the extensive participation and personal involvement in negotiations should result in situations where individuals gain control in their work).

However, there are risks in the post-bureaucratic setting to which several authors point that are central when it comes to understanding how R&D alliances work systems should be designed and managed in order to become sustainable.

First, several authors question the suggested new roles that individuals are expected to fulfill. The critique generally concerns the fact that the missing pre-defined roles in a bureaucracy will put a lot of challenging demands on individuals in the post-bureaucratic organizational setting (e.g. Hage, 1995). Such self-designed roles are not only difficult to comprehend and understand, which could lead to the failure in fulfilling them. They also risk individuals' resources to be consumed due to the hard work that relates to understanding and creating them. In addition, these roles are created to deal with more complex tasks incorporated in post-bureaucratic work, which could also be seen as threatening for the regenerative aspects of this type of work.

When the work demands more openness due to its collaborative nature and people must face situations where they risk being seen as incompetent when not having the right answers, is another important issue related to these new roles that Krackhardt (1994) addresses. In particular, in relation to performance in post-bureaucratic setting where people may be evaluated based on peer evaluation, which will result in a relatively detailed view among employees about each other's strengths and weaknesses (Heckscher, 1994). These issues might be even more demanding when the collaborative actions span across the boundaries of two different organizational settings. Although R&D alliances are usually temporary, differences in culture and context in the two organizations may indicate that these role negotiations will be more demanding. Without detailed job descriptions and work systems that demand for tasks to be solved collectively, trust is critical: for example, in order to reduce risks related to suspicions of private rather than common gains (e.g. Heckscher, 1994). Such trust-based role negotiations could be claimed to be even more complex in alliances (e.g. how to estimate what to expect in return for an effort made in favor of an individual in the partner's organization to ensure a sense of equity (Ring and Van de Ven, 1994) when not knowing the other party's resources, history, etc.).

On the positive side, Hage (1995) claims that when individuals are involved in such role negotiations and task defining - and is successful - they get a better understanding of their complex social context. Thereby, they will also be less tied to approval from authorities and, therefore, more open for integration. Thus, the results could be a positive spiral feeding itself if they are incrementally introduced and collaboratively developed.

Furthermore, a number of skills are described to be particularly important in order to cope with these risks of the post-bureaucratic system. Kira (2003) summarizes three factors, based on Mohrman and Cohen (1995) and Hage (1995), which will help individuals to cope within the emerging post-bureaucratic system (see Table 5).

Table 5. Skills in the Post-Bureaucratic Organization. Source: Kira (2003)

Competencies: Technical competencies become more and more important, but also other competence areas gain in importance. The whole notion of job competence expands to include planning and setting goals as well as negotiating one's task and goals with co-workers (interdependent as they are). Hage (1995) also underlines the need to master symbolic communication. Interaction with others, the subtle negotiations on tasks, roles, and goals necessitates the understanding of non-verbal, emotional messages sent by the other party.

Cognition: Cognitive demands will expand in the emerging organizations beyond special knowledge; people have to learn to understand the ideas and the intellectual frameworks of others as well. Furthermore, Hage (1995) suggests that, as pre-defined role scripts do not exist anymore, each person will have to create creative and flexible solutions to unique daily problems. Thus, creative minds and flexibility are needed.

Caring and Commitment: In order to be internally motivated, employees have to be committed to their work. The personal goals and sense of Self become intertwined with work role. Caring for other employees and being committed to working together with them goes hand in hand with work commitment, since so much of work is interdependent.

Furthermore, Hage (1995) suggests that not only people need to have the skills to cope with the complex organization and role negotiations; the speed of change will also demand creativity and flexibility.

Moreover, the post-bureaucratic setting will affect leadership in the organizational due to the change in hierarchy and the line of command. This often means that the individuals facing the actual situation will have to make the decisions and set the priorities, and without the same formal support that might be offered in a bureaucratic system. This situation is illustrated in Table 6, showing affective states that differ between the bureaucracy and the post-bureaucracy.

Table 6. Some Affective States in Bureaucratic and Post-bureaucratic Systems, According to Hirschhorn (1997)

Affective State	Bureaucracy	Post-Bureaucracy
Dependency	Dependency between managers and employees is depersonalized, everyone acts according to their role.	Both employees and managers depend on each other and the dependencies relate to persons, not roles.
Envy	The allocation of resources in an organization depends on the positions and envy can be projected to the positions, not to people.	The allocation of resources depends on what is prioritized by the management. If the management does not share openly their passions and priorities, envious relations may emerge directly between people. Favoritism is a problem.
Abdication of authority	Authority rests on bureaucratic rules. In a way, managers have abdicated their authority to rules and cannot anymore share their leadership through relationships.	Managers contain the potential conflicts between departments and represent interests and goals of the whole organization. The authority is not abdicated but shared in relationships.

Without bureaucratic rules, building trust and integrity will be leaders' key abilities in order to cope with the affected states (as described in Table 6). Moreover, alliances could

be problematic where the leader is favored by one of the partners' organizations, or if favoritism is suspected. In addition, decentralized decision-making indicates that both project leaders and engineers could be expected to face leadership-related issues, as aforementioned. This could be seen as extra challenging for individuals with less experience on these matters, due to differences in cultural and contextual settings, leadership styles, decision-making practices, etc. in the alliance.

Furthermore, authors address some specific negative consequences related to collaboration that could be expected in the post-bureaucratic setting, which directly threaten the regenerative aspects of work. For example, Hirschhorn (1997) acknowledges dangers due to the openness in inter-personal relationships and stresses that such relationships are related to highly challenging behavior. Therefore, there are risks that openness will not be the result; instead, people could be increasingly anxious as a reaction to these demands. Furthermore, some researchers are even more concerned and point to more widespread negative effects emerging from the post-bureaucratic organizational setting. Gordon (1994), for example, proposes a scenario where the total dependency on negotiations is not realistic, since everyone cannot negotiate with everyone else. As a consequence, Gordon suggests that subgroups could emerge, which might be engaged in non-productive competitions. Moreover, Krackhardt (1994) foresees problems related to access and dialogue: knowing whom to contact and the issues of overload is both seen as risks (e.g. in relation to specialists who might be contacted by a large number of individuals in the organization). In relation to these issues, anxiousness is to be expected in alliances, particularly since both peoples' roles and their context are usually lesser known than in role negotiations. Moreover, if the trust is broken between individuals in the two organizations, this also implies that the informal setting would increase the likelihood of "us and them" conflicts between the companies.

As previously mentioned, new paradigms in work organizations are not likely to be introduced in stepwise changes; instead, continuous efforts seem to introduce new systems and work practices by incremental adaptations and adjustments. As such, several paradigms simultaneously affect most work systems, which could lead to contradictions and sub-optimization and, therefore, high work intensity (Docherty *et al.*, 2002a). In product development work, new approaches to the development process aim to increase innovativeness and reduce lead-times, (e.g. by increased collaboration and decentralization of power, etc.) At the same time, formal processes and structures that relate to the coordination of market introduction of new products – with a highly bureaucratic signature - still influence product development work systems. This is especially true in larger organizations.

In inter-organizational relations, it could be particularly expected that individuals will risk being involved in operative work where collaborative tasks and coordination activities towards the partner in the R&D alliance could demand a more post-bureaucratic approach than the in-house work system of the partners' own firms (e.g. Doz, 1996). For example, an operative R&D alliance leader's responsibilities will often be directly linked to other more formalized activities in their own firm (e.g. to traditional product development process of which the alliance outcome could be a part). This indicates that the R&D alliance work could be particularly exposed to clashes between demands from both less formalized and more formalized settings.

Therefore, it is important to stress that negative effects have been shown when such imbalances exist: for example, if jobs are designed in a post-bureaucratic manner, but the work organization is still bureaucratic (Kira and Forslin, 2008). When comparing the situation expected in the R&D alliance to the different combinations of work and organizational approaches presented in Table 7, two types of clashes could be expected. First, for individuals going into the alliance who come from more formal in-house product development work, might be strongly tied to bureaucratic nature of work, and therefore risk experiencing *expanding* work situations (e.g. not being able to manage the informal opportunities in the alliance setting.) Moreover, when adapting to the alliance nature of work and then facing situations where alliance related tasks interact with the more bureaucratic nature of work in one of the partner organizations, they could end up in the typology of *confusing* work (e.g. risking not being able to adopt the flexibility and negotiated decisions from work in the alliance to the more formal and pre-defined setting in their own organization.)

Table 7. The Possible Combinations of Bureaucratic and Post-bureaucratic Approaches at Workplace.
Source: Kira and Forslin (2008)

THE NATURE OF WORK	Bureaucratic Work	Post-Bureaucratic Work
THE ORGANIZATIONAL APPROACH	<ul style="list-style-type: none"> • Predefined, clear job • Confined work • Limited responsibility area 	<ul style="list-style-type: none"> • Not predefined work • Broad (boundaryless) responsibility
Bureaucratic Organization <ul style="list-style-type: none"> • Impersonal • Controllability • Pre-planning • Rules and regulations • Managerial authority 	Confined working <ul style="list-style-type: none"> • Employees as “parts of a machine” • Potential for consuming work through monotony (“rust-out”) • Reduced sources of ambiguity, uncertainty 	Confusing working <ul style="list-style-type: none"> • Organization not supporting work • Potential for consuming work (“burnout”)
Post-Bureaucratic Organization <ul style="list-style-type: none"> • Little pre-definition • Decentralization • Guidelines and dialog • Flat structure/both ways • Managers as coaches 	Expanding working <ul style="list-style-type: none"> • Potential for “good work” in the Sociotechnical sense – increasing degree of participation and task wholeness • Employees cannot utilize opportunities granted by organization as their daily work is bureaucratically confined 	Regenerative working <ul style="list-style-type: none"> • Organization supporting comprehending and managing with complex, meaningful work • Potential for regenerative work

The concepts of “rust-out” and “burn-out” are used here as in Hobfoll (1998).

Although a positive implication of the situations described in Table 7 is that, as product development work systems within companies are adapted to new approaches according to post-bureaucratic principles of work, the greater the possibility of regenerative work between companies. In conclusion, these mismatches could be expected to be problematic in most organizations that experience a shift towards a less formalized and post-bureaucratic work system; however, we have described that they are also to be expected and problematic in the interactions between an R&D alliance and the rest of the partners’ organizations.

Regeneration of Human Resources and Sustainable Work Systems

Despite all the promising aspects of less formalized work systems and more personified jobs, problems and imbalances in work are not gone. They have taken new shapes (e.g. Docherty *et al.*, 2002a). For example, Docherty *et al.* refers to *The Second European Survey On Working Conditions*, which shows that the occupational group “professionals” is the most exposed to stress (reporting 39%). Hence, the new problems and imbalances in work also relate to knowledge workers: people with jobs often thought to make individuals grow and develop.

How then could post-bureaucratic work systems become regenerative? (That is, work systems that support the regeneration of human resources and contribute to the growth and development of individuals). Since old structures remain and new approaches are complex and highly diversified, the patterns describing a complete replacement of the bureaucracy are still blurred. But, as Docherty *et al.* (2002a) argues, one thing is common for imbalances in modern work life: their sources also carry the potential for the positive aspects of work, such as growth and well-being.

Therefore, individuals who are provided with the right prerequisites could affect such imbalances and could also prevent the consumption of human resources, and even make them grow (that is, regenerative work). These resources, aligned with the firm’s strategy, could also make work systems flexible, open for innovation, and competitive (that is, sustainable work systems).

Kira (2003) suggests two concepts for a work system to be regenerative, which both carry the similar fundamental idea: an optimal working experience could lead to an individual’s growth of personal resources. These are the concepts of *Sense of Coherence* (Antonovsky, 1987a,b) and *Flow* (Csikszentmihalyi, 1990).

Kira (2003) refers to Antonovsky’s (1987a,b) characterizations of an optimal experience as being dependent on both the character of the experience; that is to say, if it contains the psychological resources that make it comprehensible, manageable, and meaningful, as well as the individual’s experience history and consequent Sense of Coherence. Kira claims that a regenerative work situation that contributes to a person’s growth of resources is characterized by comprehensibility, manageability, and meaningfulness.

As Kira refers and mainly based on Antonovsky, these three characteristics of experiences relate to work as follows: a *comprehensive* situation is described as one where employees experience ordered, consistent, structured, and clear information, which results in a situation where they can predict the way things will precede. This also implies that the circumstance makes sense both emotionally and cognitively, and that one receives sufficient information to understand the context of one’s work and how it relates to the work of others. In order to be *manageable*, sufficient resources must be available to cope with the work (Antonovsky, 1987a,b). Resources must also be balanced with the demands of the situation, since both *overload* and *underload* can result in low manageability. In addition, formal and informal social structures influence the manageability of a situation. The formal social structures should be trusted in order to support the right environment and equipments to do a good work (e.g. to trust that others fulfill their duties in the work setting). In addition, the informal social structures are needed (e.g. when something goes wrong and an individual needs help). *Meaningfulness* in work means perceiving that the demands encountered are worth the investment of energy, commitment, and engagement

in carrying out the work (Antonovsky, 1987a,b). To sense meaningfulness, the employee needs to perceive the whole work process and his/her connection to it as meaningful. Meaningfulness also relates to joy and pride: both as dependent on the employee's own valuation of work and on the way society in general evaluates the work and the work organization. Hence, this includes both intrinsic and instrumental gratifications from work (e.g. internal work motivation and monetary awards.) Kira (2003) summarizes the following situations from several authors: an individual experiences work as meaningful (1) from the work itself when it is essentially rewarding, (2) from one's own and society in general that value work and the organization of the work, and/or (3) when producing or providing a service that could directly show the value of the work to others. Hence, an organization that continuously provides the individual with work experiences that have these characteristics will, therefore, support the individual and let personal resources grow.

Csikszentmihalyi (1990) states that the work experience not only depends on its character; it also depends on the individual's reaction to the situation. As such, the *flow experience* is the enjoyment that comes from continuously mastering of one's consciousness. In order to experience flow, the individual needs to be able to focus on relevant challenges in situations that include numerous stimuli and contradictions. This will require skills, clear goals, and feedback for the specific task: a balance of work and personal resources. Moreover, if the goals at work do not correspond to the personal goals of the individual, flow experiences at work seem to be missing. However, if goals at work correlate with the goals of the individual, then (instead of being consuming) work could lead to experiences of flow where a person masters his/hers consciousness and concentrates their resources on dealing with the complexities of work.

Both the concept of sense of coherence and flow could relate to regenerative work, by describing how experiences at work could build psychological resources. As such, sense of coherence focuses on the psychological resources, thus, enabling individuals to cope with work; flow complements these aspects by focusing on the process that leads to enjoyment of work (Kira, 2002).

However, designing sustainable work systems will be a challenge and highly dependent on specific contexts (Docherty *et al*, 2002b). In this last section of the frame of reference, some of the expected challenges and opportunities of post-bureaucratic (or less formalized) work have been underlined as they relate to the R&D alliance operation. The examples show that there are the same factors that represent the threats in this type of work that also make an organization successful. Therefore, they are decisive for a work system to be sustainable (Docherty *et al*, 2002a).

On the one hand, as jobs become more personified in post-bureaucratic work, joint efforts and accomplishments could represent great possibilities for the individual to grow. On the other hand, since they are more directly linked *to* them as persons, these problems and imbalances at work may become more severe for them to handle. In addition, problems may be more difficult to locate and adjust in flexible and boundaryless organizations: where work practices are tailored around specific contexts and peoples' skills and creativity are more directly connected to the value-creation of the company (Docherty *et al*, 2002b).

The expert design of jobs based on detailed predefined responsibilities and tasks will clearly not fit with the character of flexible and boundary less organizations, where bureaucratic structures and rules are reduced (Docherty *et al.*, 2002b). Instead, post-bureaucratic work design should be based on principles (e.g. Heckscher, 1994). If such a design leads to new individual capabilities, then this will contribute to a work system having the capacity to continuously adapt to changes in its surrounding. However, little is known about how principles of good work can be realized in today's working life (Docherty *et al.*, 2002b).

In conclusion, both the literature on alliances and product development work systems revealed challenges and opportunities related to regenerative work in R&D alliances. Although these studies represent important results in order to understand both regenerative and competitive aspects of modern product development work, they are still exceptions. In particular, knowledge about operative work in R&D alliances is limited (Salk, 2005). However, the literature review in this section points to both the particular risks of high work intensity in the R&D alliance collaboration, as well as high failure rates related to their operation. Therefore, our knowledge of how individuals experience the operative work in an R&D alliance and how this affects the outcome of the collaboration needs to be further explored. Hence, this research aims to empirically study challenges and opportunities in the operational work in R&D alliances in order to increase the understanding of this type of work system and explore how these work systems could be sustainable.

METHOD

This chapter will discuss the research strategy: why the present methodological approach has been chosen, how it has been applied, and what the consequences are on the results. In addition, the applied methodological approach – *the Critical Incident Technique (CIT)* – will be shortly reviewed. Thus, the main purpose is to give a clear view of the research approach, the research process, and the quality of the results.

RESEARCH STRATEGY

Based on the aim of this thesis, the chosen research approach should both support the development of new knowledge regarding the operational level of inter-organizational R&D (how this work is carried out on the operational level and what do challenges/opportunities in this work imply for the individual) and ensure that these findings could be explored in relation to sustainability in this type of work systems (which implies a good understanding of individuals when coping with this type of work). The present purpose addresses both “how” and “what” questions, which have implications on the selected strategy when compared with the suggestions on research strategies by e.g. Yin (2003). “How” questions, and the need for an approach that could generate detailed descriptions including both the work system and individual behavior, points to a qualitative approach. Furthermore, Yin suggests that if “how” questions regard studying a contemporary phenomenon, which the researcher has limited possibilities to control, an exploratory case study approach is preferable. “What” questions, however, could indicate both the usage of surveys (if related to “how many”) or a qualitative exploratory approach (if, for example, related to *what* do challenges/opportunities imply for operational leaders, as in this study). From this perspective, the purpose of this thesis could be approached by a *qualitative exploratory investigation*: for example, through one or several case studies (Yin, 2003).

Consequently, studies that have aimed to examine how inter-organizational collaborations evolve over time (including the operational level) have mainly been conducted by in-depth case studies – for example Doz (1996) and Ariño and de le Torre (1998). However, with exception from the aforementioned gold standard case studies, the contributions to

this field in the last decade are limited (Salk, 2005). There could be several explanations for this, although one refers to the perceived difficulty to perform high quality in-depth case studies on alliance operations. For example, the alliance organization as a unit is often hard to define, operational activities are often unpredictable and vary in intensity over time, processes are often informal, and the outcomes are often associated with renegotiations and changing goals. In the set up of a case study, the demarcation of the system that should be investigated is a key factor (Merriam, 1994), which could be difficult when studying alliances. Moreover, despite the important contributions to the alliance operation from the aforementioned case studies, there are still many unanswered questions on the operational level of specific types of alliances - such as the R&D alliance. In particular, behavior and action of individuals on the operative level and how these relate to the outcome of a certain type of alliance are still some of the most understudied aspects of alliances; they seem to demand new and complementary research approaches (Salk, 2005; Contractor, 2005). Therefore, it seems that in spite of the strength in contextual descriptions and richness in data, the case study might not necessarily be the only or the best approach for the realization of the purpose in this research.

A case study approach, however, is often built on several data collection methods. In the aforementioned case studies by Doz (1996) and Ariño & de la Torre (1998), some of the most recognized parts of their analysis of data were based on identified events in the alliance process. One relevant strategy, therefore, could be to directly focus on critical events in the daily operation in R&D alliances, directly linked to the outcome of the collaboration. A specific methodological approach that has such a focus is the critical incident technique (CIT) (Flanagan, 1954). The CIT is an interview technique that focuses on how individuals handle critical incidents by actions, tactics, and behavior and how this relates to the outcome (e.g. of an alliance). By applying this technique on respondents in a larger number of alliances, it should also be possible to achieve generalizability of the results; this has been a particular weakness of earlier case study approaches (Chell, 1998). However, the main strength compared with the case study approach is the strong focus on critical incidents, which gives a closeness to the situations of these events: how the individuals felt, acted and used managerial tactics in the handling of the incidents, and how these relate to the outcome of the alliance. This approach, therefore, puts a direct focus on the least understood area of prior alliance research: the actions and behaviors of individuals in the operational work and how these are related to the alliance outcome (e.g. Salk, 2005). Furthermore, this approach should also generate data that describes the alliance work context as a work system through the description of the incidents and identifies challenges/opportunities for the individual. What is even more important is that this data – by the closeness to the events and the individuals – should be able to address important aspects for the exploration of sustainability in this type of work. Lastly, since critical situations could be sources of intensive work (Kira, 2002), this approach is also seen as particularly well suited for illuminating the issue of sustainability.

The selected research approach is, thus, based on a specific type of interview technique: the critical incident technique. Specifically, the study was conducted by interviewing 16 respondents – all with experience from direct involvement in the R&D alliance operative work and having an operational leader role. The interviews covered the description of the entire alliance timeline with a specific focus on critical incidents, which is critical to the outcome of the alliance, as the respondents identified.

In the following the methodological approach, the CIT will be presented in more detail. The selection of respondents will be then discussed, followed by the description of the data collection process. Thereafter, we will present the analysis of the CIT data in relation to the four appended papers and, lastly, the limitations of this research approach will be discussed.

THE CRITICAL INCIDENT TECHNIQUE

Although the CIT has not been specifically applied to the area of alliance management, this methodological approach has contributed to important results in a number of areas in social science that relates to work and management. The CIT was first developed by Flanagan (1954) for the U.S. Air Force as a means of analyzing man-machine interface in fighter jets and the suitability of pilots to continuing service. Flanagan's work could be mainly described as using the CIT to develop job requirements; however, some of the findings also resulted in the redesign of cockpits and instrument panels in the pilots' work environment (Chell, 1998).

This thesis relates to the area of industrial work science (or management science). One of the most well known studies ever made in this area was developed from a large sample of CI data: Herzberg's two-factor theory of work motivation, presented in *The Motivation to Work* (Herzberg *et al.*, 1993/1959; Linden *et al.*, 1999). Herzberg and his colleagues actively searched for a method that could complement the earlier results in the fragmented, but intensively investigated area of work attitudes. In particular, they sought for a method that could incorporate individuals concerns, needs, etc. into the factors and effects that were to be studied. With the CIT, they found an approach that simultaneously studied factors, attitudes, and effects (Herzberg *et al.*, 1993/1959). The result is a seminal work in the field of industrial work science. The study covered 600 white-collar workers (engineers and accountants); 3600 CIs was collected and analyzed by a team of six psychologists and represents an excellent example of how the CIT could be used to discover new aspects in such a well-studied area as work attitudes and work motivation.

The method has then been developed to become a well-established methodology in several research areas. One branch of this development where the method is frequently in use today is the study of the interactions between service providers and customers: for example, in areas such as health professionals (e.g. Bradley, 1992) and service management (e.g. Olsen, 1992; Edvardsson and Roos, 2001). Even more closely related to this thesis, the CIT has recently been successfully applied in management and organization studies, such as project management (Kaulio, 2008), entrepreneurship (Kaulio, 2003), and conditions of trust (Butler, 1991).

This method can be applied in several forms if one goes into more specific methodological aspects of the CIT. The CIT data can be collected either by a pre-defined number of incidents from each respondent or based on a non-defined number, identified by the respondent. This could be done by pre-developed instruments or by an in-depth interview. The number of incidents (both positive and negative) in this study were defined by the respondents and collected by an in-depth interview that covers the entire alliance time-line with a focus on the identified critical incidents. Moreover, the applied version of the CIT in this study follows the definition by Chell (1998, p. 56):

“...a qualitative interview procedure, which facilitates the investigation of significant occurrences (events, incidents, processes or issues) identified by the respondent, the way they are managed, and the outcomes in terms of perceived effects. The objective is to gain an understanding of the incident from the perspective of the individual, taking into account cognitive, affective and behavioral elements.” (Chell, 1998).

The CIT has been compared in this presentation with the case study approach and arguments for this method that relates to the purpose of this thesis has been given. In more detail, however, the CIT has specific advantages and disadvantages compared to other qualitative data collection methods: such as participation observations and unstructured and structured interviews, which will be briefly addressed in the following section.

Compared with *participative observation*, which several authors have suggested for research on alliance operational issues (e.g. Ring and Van de Ven, 1994), the CIT cannot obviously offer the direct observation. The CIT is retrospective and details of recall can be influenced by time (Edvardsson and Roos, 2001). However, the incidents are critical, which indicate good recalls from the respondents (Chell, 1998). A particular strength of the CIT is the direct relationship between the incident and the outcome, which might not be the case in the “here and now” focused participative observation. Moreover, another strength of the CIT is the fact that the respondent (the subject) describes the context in relation to the incidents and related actions, behaviors etc.

Furthermore, the CIT benefits from a focus on the critical aspects, if compared with *unstructured interviews*. This enables the interviewer to use the incidents as a “hook” and probe for detailed descriptions around this issue (Chell, 1998). This concentration around the incidents is the core in the CIT, enabling the generation of context rich data including feelings, behavior, etc. These are also related to the outcome of the situation – all described by the subject. Such issue-strategy-outcome relations described in context are, therefore, a particular strength when analyzing the CIT material: where repetitions in patterns of managerial tactics, etc. can be identified by how individuals handle critical situations (Chell, 1998). An unstructured interview may not offer the same “readiness” of the data where the CIT’s focus on events is explicated regarding the cause, the course, and the result. In combination with multi-site studies, this is a particular strength of the CIT where the categorization of incidents with commonalities in themes in the analysis can create both qualitative and quantitative evidence across samples. This enables some generalization of the findings. However, the focus on the critical aspect in the CIT is also a weakness in that this interview technique may not uncover non-critical issues, which other approaches (for example, unstructured interviews) can reveal. Although, the in-depth interview approach adopted in this thesis (covering the entire alliance timeline) is significantly better in this aspect than the usage of instruments. Moreover, since the technique is focused on critical aspects, concerns could also be raised for the need to be extra careful regarding confidentiality issues. Critical incident can unveil, for example, ethical issues, which can be problematic if one is not prepared in advance of a CIT study.

Lastly, a particular strength of the CIT in relation to *structured interviews* is that the respondents themselves identify the critical incidents. This enables the uncovering of unexpected issues related to the studied phenomenon, which may not be the case if the interview is pre-structured.

To summarize, the following strengths of the CIT could be related to the purpose of this thesis. First, the main strength of this approach lies in the detailed descriptions of the incidents, how these are handled, and what is the outcome, in relation to creating new knowledge regarding the R&D alliance work system and what do challenges/opportunities in this work imply for the individual. Therefore, the CIT should be able to generate new knowledge and contribute to the least understood area of alliance research, where other research approaches have shown limitations. Second, the possible use of the multi-site approach on a well-defined sample of R&D alliances - where the data could be aggregated and categorized, generating both qualitative data and quantitative (frequency of incidents in relation to categories) - will be a particular contribution to the alliance research (where broad surveys or case studies have been the dominant approaches).

Moreover, the CIT approach also shows specific strengths in relation to the aim of exploring sustainability in this type of work system. Since a sustainable work system should be both competitive and regenerative, the analysis of the data from this approach should not only cover performance aspects of the R&D alliance work system; it should also enable the exploration of regenerative aspects of this work (e.g. how individuals cope with this type of work in terms of comprehensibility, manageability, and meaningfulness) (Antonovsky, 1987a,b; Kira, 2003). In line with previous results from using the CIT (such as the substantial study by Herzberg *et al.*, 1993/1959) the detailed results regarding how individuals cope with critical incidents in the R&D alliance work should be a particular strength of the CIT approach when exploring sustainability in this inter-organizational setting. In addition, since intensity in work is regarded as negatively influencing regenerative aspects of work (Docherty *et al.*, 2002a; Kira, 2002) the focus on critical incidents could be a particular strength of this approach in this aspect, due to the likelihood that critical situations will increase the intensity in the work.

SELECTION OF RESPONDENTS

A total of 16 respondents were interviewed using in-depth CIT interviews. The respondents represent seven companies and 14 R&D alliances from four industries, as shown in Table 8.

Table 8. Sample of Respondents and Industries

<i>Industry</i>	# of Respondents
TeleCom	2
Manufacturing	8
Med-Tech	4
Process Equipment	2
Total	16

The respondents were identified using a 3-step process. First, a set of 7 companies was identified that develop complex devices, products or systems based upon several different technologies (e.g. vehicles, medical technology, production systems, and telecommunication systems). These companies had previous experience of at least one completed R&D alliance. With these criteria, the sample represents typical industrial R&D alliance projects based on similar integrated product development processes and alliance projects that do not represent a first time project of the specific company.

Secondly, 14 alliance projects were selected from the sample companies, all meeting Yoshino and Srinivasa's definition of a contract-based R&D alliance (1995, p. 5):

“(1) The two or more firms that unite to pursue a set of agreed upon goals remain independent subsequent to the formation of the alliance; (2) The partner firms share the benefits of the alliance and control over the performance of assigned tasks – perhaps the most distinctive characteristic of alliances and the one that makes them so difficult to manage; and, (3) The partner firms contribute on a continuing basis in one or more key strategic areas, e.g., technology, products and so fourth”.

To define the specific case of an R&D alliance, the following criteria will supplement Yoshino and Srinivasa's definition of an alliance: the overall purpose of the alliance should refer to tasks carried out by the product development function and relate to new product development. That is, the product development work will not include development of, for example, the firms' production system. Neither will it incorporate minor product upgrading nor product or service upgrading in the end of the product life cycle. By these criteria the relation between the partners in the alliance, the purpose, and the engineering work are aimed to be comparable across the sample.

Third, the companies were asked to identify individuals who possessed particularly good insight and experience from the operative work in the selected R&D alliance projects. The final selection of respondents was comprised of alliance leaders in various roles; their roles stretched from engineers with responsibilities for parts of the alliance product development (e.g. an object leader role), to alliance managers who were responsibilities for the entire alliance project. This meant that these individuals were deeply involved in the alliance operational work and their responsibilities carried some personal risks in relation to the alliance work.

All of the interviews were conducted with the Swedish part of an international alliance, with the exception of one, which was conducted with one part of an R&D alliance between two Swedish companies. The interviews were conducted in the Stockholm area during the spring of 2004. Table 9 below, shows the sample of alliance in some detail related to the respondents and the number of identified critical incidents (CIs).

Table 9. Description of the Total Sample of Respondents and R&D Alliances Projects in this Thesis

Respondents	Company	Type of Alliance (Dyadic or Network);	Alliance Nationality	Size of Partners (Stud./Partner)	Industry Relation	# CI
Resp. 1	A	Dyadic	National	Small/Large	R&D Partners	5
Resp. 2	A	Dyadic	International	Small/Large	R&D Partners	5
Resp. 3	B	Dyadic	International	Large/Large	R&D Partners	8
Resp. 4	B	Dyadic	International	Large/Large	System Integration	9
Resp. 5	C	Dyadic	International	Large/Large	System Integration	8
Resp. 6	C	Dyadic	International	Large/Large	System Integration	23
Resp. 7, 8	C	Dyadic	International	Large/Large	R&D Partners/ Competitors	9
Resp. 9	C	Dyadic	International	Large/Large	System Integration	10
Resp. 10	D	Dyadic	International	Medium/Large	R&D Partners	8
Resp. 11	D	Dyadic	International	Medium/Small	R&D Partners	14
Resp. 12, 13	E	Dyadic	International	Large/Large	System Integration	15
Resp. 14	F	Dyadic	International	Large/Small	System Integration	10
Resp. 15	F	Dyadic	International	Large/Medium	System Integration	22
Resp. 16	G	Dyadic/ Network	International	Large/Medium	System Integration	12
Total: 16	Total: 7					Total: 158

The number of employees that actually participated in each alliance varied from 6 to 70 based on how it was described in, for example, the project documentation etc. However, how to define the exact number of participants is difficult and how these issues were stated in secondary data sources may not give the best picture. A result from this study actually indicates that prior alliance research may have overemphasized the explicitly of e.g. R&D alliance projects in terms of resources, team members, timeframe, and geographical location, etc. With the purpose of this study, it may be more interesting to look at the number of people who were directly involved in regular meetings between the firms, which varied from approximately 6 to 15 in the 14 R&D alliances. In terms of project duration, alliance project 1 and 2 were short (approx. 6 month), alliance project 3-6 and 9-12 lasted one to five years, and alliance project 7,8,13,14 were six to ten years in duration. However, determining the actual length of an R&D alliance is also difficult. Four of the 14 R&D alliances were in the last part of the project and the product development process, and were approaching a product introduction when the interview(s) were conducted. The product had been introduced in the rest of the alliance projects and the R&D alliance project was completed. Nevertheless, product development projects and R&D alliance relationships are complex, overlapping in time - sometimes parallel - and often sequential in terms of product generations. In addition, the product in a R&D alliance is often related to other product development processes (e.g. by being a subsystem in a larger product or system). This also means that engineers in the R&D alliance project are often situated in a multi-project environment: where parts of their work could be devoted to projects outside the R&D alliance project, etc. In contrast to earlier research, where the alliance often is described as a rather defined organizational unit, it could be important to adapt a more complex picture of the R&D alliance project (e.g. in relation to its boundaries and involved resources). In sum, although it is not

possible to prove that the variations across this sample could not affect the results of this study, the sample is argued to be more homogeneous than many other studies of alliances and therefore also representing an adequate sample for this investigation (e.g. due to the definition of alliances, purposes, and technologies).

DATA COLLECTION AND INTERVIEW PROCEDURE

The CIT interviews were conducted with operational leaders directly involved in the R&D work-processes of the studied alliances. The author and a colleague interviewed the first four respondents in Table 9; the author alone conducted the later twelve interviews. Respondents 7 and 8 were interviewed separately regarding the same project (see comments in last section on validity), whereas respondents 12 and 13 were interviewed together.

The procedure of an interview was the following: first, a contact was established with the respondent by telephone in which the purpose and the methodology of the study were presented. Specifically, the respondent was asked to prepare by thinking about the R&D alliance project, recall the alliance timeline, and the incidents that had been critical to the alliance outcome. Thereafter, a document describing the background of the study, exemplifications related to the interview and the method as well as a broad view of the expected results, was sent to the respondent as confirmation. To define a critical incident the following definition, as proposed by Olsen (1992), was used in this study: *an event that deviates from the expectations of the actor*. Further criteria for an incident is that it should be (i) possible to identify, (ii) possible to demarcate and (iii) have had a critical influence – or have had the potential of having a critical influence – on the outcome of the alliance.

The interview started with questions regarding the company and past alliances. In order to give the alliance a setting, facts about purpose, scope, partners, duration, and resources in the alliance was covered. There were also questions about the respondent's part in the alliance. Then, followed the critical incidents part of the interview. The respondents were asked to go through the entire alliance project based on a thought timeline of the project and to recall positive and negative incidents critical in relation to the project outcome. In addition, questions, if needed, were asked to clarify details of the incidents (e.g. related to actions and behavioral issues in coping with the critical incident). Finally, both parties had the opportunity in an informal roundup to ask any additional questions. The interviews lasted between one-and-a-half to three hours. The interview notes were transcribed and sent to the respective respondent for a review, and for any comments and corrections.

In addition to the interview, all of the respondents were invited for a half day workshop where the first analysis of the results were comment upon and discussed – partly as an extra validation measure and partly for a knowledge and experience forum. This event gathered half of the respondents.

Pertaining to the data collection, controlling the CIT interview and staying focused on the incidents could be demanding; the quality of the results depends on the skills of the interviewer (Chell, 1998). In particular, being able to probe and obtain an in-depth understanding of the described situations, this interview technique relies on interactions where the interviewer must clearly follow the respondent descriptions, ask any extra questions, and seek details and clarifications. In such situations, the author's background as an engineer (working in similar work environments as the respondents) was important

in having detailed discussions and gaining the respondents' confidence. In addition, a reflection was also that there was a need to talk about these alliance related issues, which may have also contributed to the richness of this interview data. The interviews were sometimes perceived as giving the respondents the opportunity, which they may not have been given before, to discuss experiences and feelings.

EXPLORING THE CIT DATA

One of the key questions of the CIT method in general, and with this thesis in particular, is how to explore the CIT data. The dataset earned from the interviews consists of two entities: (1) the actual 158 CIs, where each incident is described separately, along with basic contextual data; and (2) a detailed data material from the in-depth interviews, covering the full description of each incident and how they were embedded in the reported timeline of the alliance process of the 14 studied R&D alliances.

Since being conducted by an open, in-depth approach, the analysis of the data features both the categorization of the CIs (generating the quantitative number of CIs in each category), as well as the qualitative analysis of the total data material (giving details and insights to specific incidents and, through this, a detailed understanding of the challenges related to each category).

The CIs have been the unit of analysis in each of the papers. The CIs are described from the view of the respondents and were defined as being critical, regarding the R&D alliance project outcome. With this design (and definition of a CI), this study intends to capture both a detailed picture of critical issues on the operative level of the R&D alliance projects and central aspects of sustainability in the studied projects (that is, regenerative aspects of the individuals in the alliance work as well as competitive issues related to the performance of these projects).

In Figure 8, an illustration is given showing two subsequent CIs in one R&D alliance project. Each incident could either be positive or negative and is described regarding how it emerged, what was the critical aspect (positive or negative to the alliance outcome), how it was handled, and what was the outcome. In these descriptions, many aspects of individuals' tactics, feelings, behaviors, etc. were related to the handling of the incidents. Moreover, as illustrated in Figure 8, the data material from the in-depth interviews covered the whole of the alliance project as the respondents described, based on the alliance timeline.

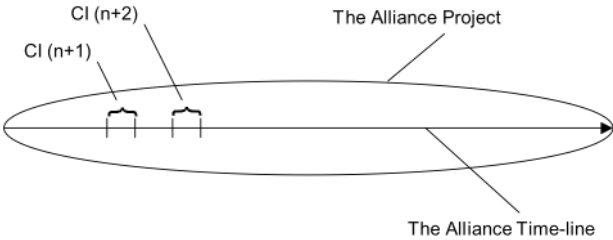


Figure 8. Schematic illustration of critical incidents in relation to alliance project and timeline.

Several approaches can be adopted to analyze a CIT dataset, which also depend on how the incidents have been collected. However, the central issue in analyzing the CIT data is the categorization of the incidents. When conducted from a multi-site study, as in this case, it must be decided if the incidents should be analyzed per case or on an aggregated level. Both of these approaches have been used in the four analyses performed: three are based on the whole dataset, on an aggregated level, and one on a sub-sample of four alliances, analyzed per project.

More specifically, three approaches have been used in the categorizations. Following the in-depth interview approach for conducting the CIT data, the basic outline of categorizations is in line with the three principles that Chell describes in *Qualitative Methods & Analysis in Organizational Research* (1998). These will be briefly reviewed in the following and a more detailed description of the analysis will then be performed in relation to the four appended papers presented in this thesis. Perhaps the most common way to categorize critical incidents is the grounded approach. This is based on an analysis of *communalities in themes* or aspects of the described incidents. As such, this approach is the most effective in finding new aspects of the investigated subject. The grounded theory approach was adopted in Paper 1 for the first part of the categorizations, as Chell described (1998, p. 60):

“Grounded theory assumes, on the whole, that the researcher abandons preconceptions and, through the process of analysis, builds up an explanatory framework through conceptualization of the data. Thus there emerge categories of behavior, contexts and types of outcomes associated with the particularities of context and strategies adopted for dealing with it.”

If the analysis of CIT data aims to focus on a specific aspect of the investigated subject, then a pre-developed framework could be used as a coding frame for the categorization. Such an approach was adopted in Papers 2 and 4 where two conceptual frameworks were developed and tested through the CIT data. Chell (1998, p. 60) describes this approach as follows:

“An extant conceptual framework, on the other hand, suggests a set of preconceived categories – a coding frame – for which evidence may be sought for in the data. Such a framework may be not only tested but also extended using the CIT methodology”

For Paper 3, a third approach was used in analyzing the data. Here the focus was on a subset of alliance projects in the dataset that had distinctive differences and similarities. The incidents were analyzed per case in relation to a specific issue that related to the differences between the alliances in the sub-sample. They were also content analyzed per case to find evidence of other differences and similarities regarding the identified incidents. In relation to this approach, Chell (1998, p. 68) describes the principle for the analysis as the following:

“...the CIT enables the researcher to gain insights both into particular cases and across a sample of cases. For example, if the subset of cases is...[uniqueness x, y, z] ...etc., then what are the typical issues, which are raised by the particular subset? Is there a common set of problems? What do they need to know in order to be able to handle those problems?”

In addition to the categorization of each incident, a qualitative analysis follows where details from the incidents in each category are thoroughly examined to exemplify and put the incidents into its respective context in order to explore the qualitative aspects of all the interview data. In the following, we will present the procedures for how the CIT data has been explored in this thesis. Table 10 shows an overview of the different approaches in analyzing the data from the CIT study among the appending papers.

Table 10. Differences in Methodical Approaches of the Analysis of CIs in Papers 1, 2, 3, and 4

Paper	Dataset analyzed (#CIs)	Purpose	Principle of analysis	Categories/Themes
1	158 (All CIs and all qualitative interview data from 14 R&D alliances)	General picture, identification of the most important issues in R&D alliance work to analyze role-prerequisites of alliance managers	Categorization through grounded conceptualization of the data then arranged into five higher level, themes of a pre-developed framework	Identified explanatory categories through conceptualization of the data and then related to five themes of conceptual framework describing the alliance operation
2	158 (All CIs and all qualitative interview data from 14 R&D alliances)	Testing and extended understanding of theory (Related to trust formation in R&D alliances)	Examination and categorization of data through categories based on extant conceptual framework	Three trust formation-related categories based on extant conceptual framework
3	49 (CIs and qualitative interview data from subset of 4 R&D alliances)	Understanding of R&D alliance operation and the influence of two types of risks among subset of projects	Analysis of CI per case and comparing between cases with distinctive differences in context	CIs associated with individual projects with a focus on two types of risks
4	158 (All CIs and all qualitative interview data from 14 R&D alliances)	Testing and extended understanding of theory (Related to HRM in R&D alliances)	Examination and categorization of data through categories based on extant conceptual framework	Five HRM related categories based on extant conceptual framework

There is logic in how the sequence of analyzes have evolved in this study. After the first analysis, based on the grounded approach in an early version of Paper 1, it becomes clear that the data contained more information than was possible to explore from only one analysis. As also Chell (1998) described, the usage of the critical incidents as a unit of analysis also allows for the focus in categorization and analysis to shift. The conceptualization of the data in Paper 1 was based on an analysis of the critical aspect of each incident in relation to the alliance outcome, resulting in 20 sub-categories of critical aspects. These were then arranged in a second step into a pre-developed framework of alliance operation. In Papers 2 and 4, the categorizations were based on pre-developed frameworks used to content analyze the incidents due to the specific topic of the framework. In Paper 3, four R&D alliance projects were selected in order to analyze the influence of different risk settings of the alliance that was related to projects, companies, and industries. This was done by comparing risk-related factors that influenced the incidents of each project. A more detailed description of each analysis will be outlined in the following section.

In Paper 1, the CIT data was analyzed using a multi-step process that involved both of the authors. Initially, each incident description was printed-out and arranged on walls. A process that could then be described as a categorization of ideas (Kvale, 1997; Chell, 1998) began where categories were created upon the basis of similarities in the issues that

were addressed to be critical in relation to the alliance outcome in each of the incidents. From this process, the 158 incidents were categorized into 20 categories related to themes. In the next step, these 20 categories were then arranged using a pre-developed framework of five categories of the R&D alliance operation (Formation, Formal R&D Process, Informal Relationships, Embeddedness, and Exit).

The analysis in Paper 2 was based on a pre-developed conceptual framework that describes three trust formation mechanisms. The author performed the categorization in this paper in two steps. First, each incident was content analyzed and coded regarding whether the outcome of the CI described a change in the level of trust between the partners. In some cases, a comment in the critical incident description explicitly stated that the level of trust had increased or decreased. In other incident descriptions, the change in trust was identified by the description of the alliance relation as it related to the four dimensions of the trust definition applied in this paper (competence, openness, caring, and reliability). Secondly, all the incidents that were first found to relate to a change in trust level were analyzed and categorized with regards to the developed framework of trust building mechanisms.

In Paper 3 all 49 critical incidents from the four selected alliances were listed chronologically per project, along with specific contextual settings. The analysis was then made in two steps: first, each incident was content analyzed per project specifically regarding the influence on the incidents from the two types of risks related to the projects – relational risks and performance risks. Secondly, an analysis of each incident along with all of the context material was analyzed per project in order to examine whether there were other critical aspects that could be found related to the differences in contexts and risk settings of the projects.

Lastly, and similar to the analysis in Paper 2, the analysis in Paper 4 used a pre-developed framework built on the emerging literature on HRM in alliances. In this analysis, each of the 158 incidents was content analyzed and categorized regarding the specific aspects of each of the five HRM themes according to the framework.

In all of the analysis, each category (project in Paper 3) has been further analyzed. The CIT gives a rather concentrated qualitative material due to the focus on the critical incidents: where parts of the usual qualitative analysis work to concentrate the data has already been done through the CIT approach (e.g. Kvale, 1997). However, in order to take advantage of the details in the descriptions of the incident, the quantitative categorization was followed by a qualitative analysis of the incidents in each category. This also incorporated the entire interview data covering the entire alliance timeline, which serves as an important background for the qualitative analysis of the categorized incidents. From this analysis, descriptions were developed as an important part of the results from this study. This included incidents that were typical for the categories related to their social and temporal context.

QUALITY OF THE RESULTS' VALIDITY, GENERALIZABILITY, AND RELIABILITY

The quality of this study will be specifically discussed in terms of validity, generalizability, and reliability of the results in this final chapter. However, the *construct validity* on an overall level is related to the choice of using the CIT method and how it was applied in the fulfillment of this study's purpose. This has been described and motivated in the section on Research Strategy (Yin, 2003).

In a more direct relation to the quality of the results the *(internal) validity* concerns how well the results of the study correlate with what has been studied (Yin, 2003). The descriptions of research design, the requirements for data collection, and the studied subject are important aspects to evaluate the validity in this qualitative investigation. If starting with the studied sample of respondents, the selection was not done randomly; instead, respondents were selected by criteria that intended to strengthen the validity, in terms of ensuring that the respondents were well informed regarding the studied object and that they had similar roles. However, all of the interviews were conducted with Swedish respondents who were employed in the Stockholm region, which could indicate that there are specific cultural aspects related to this sample. Moreover, the respondents R&D alliance projects have also been discussed in this section. Although there are significant differences across this sample that could influence the results, it is argued to be representative for this type of work by the selection criteria that has been adopted.

In relation to the CIT interviews, several aspects of validity arise from the approach in this study. First, the *knowledge and experience of the interviewer* is related to the quality of the results (Chell, 1998; Kvale, 1997). Two such aspects were addressed. Prior to this study, the author had significant experience in conducting interviews, but no specific experience in conducting CIT interviews. Therefore, the first four interviews were conducted together with the author's supervisor (who has experience from several studies based on CIT interviews). The second aspect is that the author has significant knowledge and experience regarding professions, work, and the work system of the respondents from having previously worked as an engineer in one of the studied companies.

Secondly, *the planning of a CIT study* could have consequences on the validity of the results (e.g. Chell, 1998). Each interview in this study was carefully planned in order to provide sufficient time and a well-managed interview situation, conducted only by in-depth interviews with respondents who had been directly involved in the alliance operation.

Third, concerning the CIT interview a weakness may be the limited possibility to prove that all critical incidents have been found and that the interview is *focused on critical aspects*. In addition, this technique is related to ethical and sensible issues, due to its focus. This could affect the results, for example, from respondents that may not fully report aspects related to their own mistakes or shortcomings (e.g. untrustworthy aspects in one's own behavior). The dialogue, confidence, and trust between the interviewer and the respondents in such situations are important. The CIT is also based on *retrospective interviews*. However, the identified incidents are critical, which accounts for a good recall by the interviewees (e.g. Chell, 1998).

Fourth, measures were taken to control the *validity of the interviews*. The interviews were printed and sent to all respondents to check for errors or misunderstandings, as well as

complementary recalls. Moreover, the results from the first analysis were presented in a workshop where half of the respondents in the study participated. Lastly, two respondents were interviewed in one alliance project as a means for double sources of evidence. This test showed good correlation of identified incidents, as well as how the R&D alliance process was described.

In terms of *generalizability* of the results, it should be mentioned that the aim of this investigation is not to create results that could be statistically generalized. Instead, results from earlier studies are used to theoretically generalize the results (e.g. Eisenhardt, 1989, Strauss and Corbin, 1998). However, the *multi-site approach*, which includes 14 R&D alliance projects and 16 respondents, contributes to some confidence in an analytical generalizability of these results (Kvale, 1997). For example, the logic in some of the situations described in relation to the incidents in this study could be seen as relevant for individuals in R&D alliance projects outside the studied sample.

In addition to validity and generalizability, the quality of the results also depends on the *reliability*. That is, the possibility to replicate the study and obtain the same results. This is difficult, if not impossible when it concerns checking for reliability in the CIT interview. One measure that could be taken is to interview the same respondent more than once. However, the increase in reliability is questionable in relation to the cost of this measure (Chell, 1998). Concerning reliability of qualitative studies, it is also important to address that the aim is not to find a single truth. Instead, the importance is to understand the respondent's perspective, actions, and behavior in relation to how this affects the outcome is the important (Chell, 1998). Furthermore, reliability could always increase by narrowing the sample of studied alliances: in terms of, for example, purpose, context, and industry as well as company and alliance sizes. However, due to the extremely wide range of parameters that influence the homogeneity of a sample of R&D alliances, the selection of cases can be a well-motivated and representative sample regarding reliability.

Another important issue of reliability is related to the analysis. Specifically the categorization of the incidents must be considered in relation to this quality aspect of the results. According to Kvale (1997), two aspects of reliability should be addressed: the first is related to *how well the analytical process is described*, and the second is the *usage of several coders* or the persons conducting categorizations. The first aspect is addressed in the section of *exploring the CIT data* in this chapter. The second aspect relates to the four different analyzes of the CIT data in this study. In Paper 1, the first part of the analysis is based on a grounded approach; the categorization includes a qualitative process of creating the categories. Such a process could, therefore, be extra demanding in terms of reliability (Kvale, 1997). From this reason, the analysis in Paper 1 was conducted by two individuals in order to increase the reliability (the two authors of Paper 1). One person (the author) performed the analysis in Papers 2, 3, and 4. Although, the analyses in Papers 2 and 4 are based on a categorization of the incidents into pre-defined categories, which is less demanding in terms of reliability. This could also be argued for the coding of the incidents related to the two types of risks in Paper 3. As Andersson and Nilsson (1964) showed in a test on students, categorizing critical incidents on a first category level is often acceptable in terms of reliability. Therefore, together with other studied on the reliability of the CIT (e.g. Ronan and Lantham, 1974) one can argue that categorizations of CIs in this thesis are satisfactorily reliable.

SUMMARY OF APPENDED PAPERS

This chapter aims to summarize the appended papers and outline how they contribute to the whole of this thesis. A brief summary of each paper is offered based on the papers' purpose, main findings, as well as their specific contribution to the thesis.

All appending papers are based on the data obtained from a study of 14 R&D alliances conducted by the critical incident technique. A total of 158 critical incidents have been found in the study, which were analyzed using different methodological approaches according to the purpose in each of the papers (see *Method* chapter). Furthermore, Paper 3 differs from the other appended papers in that its analysis is based on a sub-sample of the data (49 of the 158 incidents). The differences between four selected alliances projects were compared in this paper based on the analysis of the critical incident data. In Papers 1, 2 and 4, the analysis was based on a categorization of the whole data set.

PAPER 1

Title: Critical Incidents in R&D Alliances: Uncovering Leadership Roles

Authors:* Matti Kaulio and Lars Uppvall

(*The two authors have contributed on an equal basis to the paper)

The Purpose and Main Findings of the Paper

This paper seeks to identify critical incidents that alliance operational leaders face in the execution of contract-based R&D alliances and to elicit role requirements for alliance leaders based upon these incidents. Therefore, this paper aims to contribute to a particularly neglected area in earlier alliance research – the empirical investigation on the individual level of the alliance operation – by linking these managerial challenges to specific situations: how they emerged, how they were handled, and what was the respective outcome.

The identified 158 critical incidents were analyzed and categorized into 20 categories, and then arranged according to a modified version of a general alliance process model consisting of five themes. The two dominant themes, in terms of frequency of occurrence, are managing informal relationships and alliance formation. These are then followed by formal R&D process, embeddedness and exit (see Appendix 1 for a detailed list of critical incidents related to each category and theme). The findings confirm past research that emphasizes the informal relationship as a key aspect in managing an alliance. The high number of incidents in this theme, of which the majority was positive, indicates that the informal relationship is the most critical aspect and represents an important foundation for individuals in order to overcome obstacles in the operational work. The formation theme included the second highest number and a majority of positive incidents. Earlier research has acknowledged that the formation of an alliance is a particularly important stage. However, a specific contribution from this study is the influence of operational leaders on the go/no-go decisions of having a specific partner, as well as the critical aspect of their behavior on the outcome of the contractual process. The themes of formal R&D process and embeddedness contained a majority of negative incidents. These were shown to represent specific complicated managerial issues, stemming from adoption to the partners' work practice and formal processes in the product development, as well as handling the alliance operation in relation to how it is embedded into the partner organization and supply chain network. Lastly, the theme of exit contained only a small number of incidents, indicating that the end of an R&D alliance is less critical than what could be expected from previous research – at least on the operational level. Thus, both the suggested modified process model and the findings connected to each theme and related categories represent specific contributions to alliance research.

The second objective of the paper has been to elicit role requirements for alliance leaders and was obtained based on two types of evidence: the first is the frequency of occurrence of critical incidents in three of the themes; the second type is the actual behavior of a few identified alliance managers. The first three roles relate to three main foci: Facilitating or integrating the product development processes and practices of the two organizations; Finishing or delivering incremental work packages; and, Ambassadoring or protecting and integrating the alliance into the respective organization. Each one of these roles corresponds to the themes of the formal R&D process, informal relationships, and embeddedness. Individuals who carried the fourth role – that of the Trustkeeper - were able to resolve conflicts or potential conflicting situations by having technical knowledge, an extensive network, and the ability to make fast decisions based on both parties' strategies and work practices. However, they could not only solve R&D related problem by their behavior; they were also able to maintain or even strengthen the level of trust between the partners. Hence, this paper complements earlier process-oriented research on alliances by presenting new empirical data and basic framework; this research also suggests four critical roles that are central to R&D alliance leadership.

The Contribution to the Thesis

The results directly contribute to the understanding of the R&D alliance work system and what the challenges and opportunities in this work implies for operational leaders. Furthermore, the understanding of new and extended role requirements relates to a central discourse in the emerging literature on sustainable work systems regarding

demands made on the individual in less formalized work systems. Therefore, the four roles suggested in the paper represents an additional contribution to how work in R&D alliances could become regenerative, as well as how R&D alliances could become sustainable.

PAPER 2

Title: Formation of Trust in R&D Alliances

Author: Lars Uppvall

The Purpose and Main Findings of the Paper

This paper aims to understand the formation of trust in the operative work of R&D alliances. By testing a pre-defined framework of trust formation, this paper intends to broaden the understanding of how trust relates to the operational work in R&D alliances, how it is built up and broken down over time, and how it relates to the outcome of the alliance. Based on the identified situations related to trust formation, this paper also aims to specifically address managerial implications that relate to different R&D alliance work situations.

The 158 identified critical incidents were analyzed using a pre-developed framework, based on three mechanisms of trust formation: process-based, characteristic-based, and institutional-based. Founded on the work by Zucker (1986) and Parkhe (1998b), the developed framework relates a number of managerial actions in alliances to the three mechanisms of trust formation. First, process-based formation of trust relates to the consistency of behavior over time for the creation of trust. Secondly, characteristic-based mechanism relates to specific attributes among the partners (e.g. cultural or social). Third, the concept of institutional-based trust refers to the building of trust through formal mechanisms (e.g. alliance specific investments or built-in incentives, or punishments for cheating, formulated in the alliance contract).

The overall findings showed that the trust formation mechanisms are important aspects of how trust is handled in the R&D alliance operation. More than half of the 158 incidents could be identified as influencing how trust is formed between the partners and related to one of the three mechanisms of trust formation. The most frequent trust formation mechanism related to critical incidents was that of the process-based with a majority of positive incidents. The characteristic-based mechanism was also associated a high number of incidents, however, with a majority of negative incidents. Lastly, only a small number of incidents related to the institutional-based trust formation mechanism.

On a more detailed level, the framework seems to offer important support for the understanding of how trust is built up and broken down in critical situations in an R&D alliance operation; this mainly relates to the two mechanisms: process and characteristic. In particular, the majority of positive incidents indicate that process-based trust formation mechanisms are important opportunities in R&D alliance management. The key aspects for good management has been to watch the alliance time-line, to act predictably, and to be proactive in situations with emerging problems. Moreover, to be open and transparent only related to positive incidents. Decreasing openness should be managed with great care and only if there are concrete and proven risks. On the one hand, easily observable differences in characteristics between the partners are manageable, in terms of trust. On

the other hand, hidden or neglected differences are sources of negative critical incidents related to trust. This calls for a strong managerial focus on one's own corporate culture and that of the partner. Finally, the few incidents related to the institutional-based mechanism indicate that non-recoverable investments in the common project could be used to boost the trust in specific situations. Contrary, built-in incentives in the alliance contract may result in opportunistic behavior, which is highly negative for trust.

Despite the great attention given to trust in alliance literature and a direct interest of how trust relates to the success of an alliance, there are still few studies that examine how trust is formed in the operational work of a specific alliance. The findings in the paper, therefore, represent an important contribution to alliance research by confirming the theoretical framework through the empirical support of the tested trust formation mechanisms and giving specific managerial implications on trust formation in the R&D alliance operation. Moreover, from a practitioner's point of view, most respondents stressed the importance of trust and acting trustworthy. However, trust-related issues still seemed to be rather unmanaged and, therefore, represented both the biggest threat to – and asset for – a successful R&D alliance. One of the reasons behind this might be that the micro-dynamics of how trust formation is managed in the operational work is not as obvious as the importance of trust itself.

The Contribution to the Thesis

Trust formation in inter-organizational relations relates to both challenges and opportunities in the alliance operational leaders' work. The results show how actions and behavior in the operational work influence the formation of trust, with an immediate effect on individuals' ability to manage the alliance relationship. From a sustainable work systems perspective, trust is seen as a vital support for individuals in order to cope with the demands of less formalized work systems. Therefore, the developed framework in this research represents a contribution to how trust in the alliance operation could support regenerative work and, therefore, sustainability in R&D alliances.

PAPER 3

Title: Relational and Performance Risks in Operative Work in Contract-Based R&D Alliances

Author: Lars Uppvall

The Purpose and Main Findings of the Paper

This paper examines the influence of context-related risks on the operative work in contract-based R&D alliances. Most previous research on alliances fails to grasp the complex details of contextual issues related to a specific collaboration, and is even more seldom able to associate the context to describe actions, tactics, and behaviors on the individual level of alliance operational work. However, R&D alliances are perceived as high-risk strategies and, therefore, depended upon effective management of risks coming from different potential threats (such as strategic or technological as related to specific partners and their industries). This paper aims to identify how these contextual differences influence critical aspects of the operational work through a study of four R&D alliances that share similar motives and structures, but are situated in two separate

companies with two distinctively different contextual settings associated with specific types of risks.

Risks are described here as negative variations of important outcomes, which focus on possible losses. Based on earlier research on strategic alliances (Das and Teng, 2001a,b), two conceptualizations of risks are central to this study: relational risks and performance risks. Relational risks are related to not having a good relationship (e.g. occurring from opportunistic behavior or cheating), whereas performance risk relates to unsatisfactory operational performance despite full cooperation (e.g. associated with lack of competence). In this study, two of the alliances are situated in a setting that makes the protection of the company's strategic assets particularly difficult and, therefore, sensitive to relational risks. The other two alliances are dependent upon specific competence and knowledge in order to reach the goals of the collaboration and the final product, which makes them exposed to specific performance risks.

In general, the findings from the four alliances (representing a sub-sample of 49 critical incidents from the main study of this thesis) show that the two specific contextual settings and their associated risks greatly influenced the operative work. In the alliances that were exposed to relational risks, concerns about business-related strategic risks colored the relationship on the operational level. A high number of critical incidents related to concerns that the partner could use the alliance in strategically unfavorable ways. Under such conditions, the findings show that operational leaders are dependent upon access to, and the quality of, strategic information in order to be trustworthy and, therefore, able to manage the alliance operation. Hence, strategic risks are not only a top management issue, in this type of alliance context, requirements on operational leaders will be high in terms of understanding the company's strategy and perceived competitive risks in order to handle the complex alliance operation. Conversely, in the alliances with high performance risks, none of the incidents or any other comments in the interview material were related to strategic concerns or opportunistic behavior. Instead, as expected, different types of performance risks were here mirrored in what the critical incidents concerned. Conflicts were triggered by such issues as whether the partner actually had a specific type of knowledge that was required in a specific situation, etc. The results indicate that operational leaders in this type of context have to be prepared to meet operational challenges related to difficulties in assuring the competence of a partner. There will be many requirements on operational leaders' ability to achieve early integration between the partners in terms of complex product knowledge, customer requirements as well as test certain capabilities.

This paper contributes by showing that specific types of contextual settings will influence the R&D alliance operation and the requirements made on operational leaders. The alliance relationship is dependent on trust and inter-personal relationships; however, in order to achieve this, our findings indicate that R&D alliance operational leaders must master critical incidents related to the setting of a specific alliance, such as exposure to relational risks or performance risks.

The Contribution to the Thesis

By showing how differences in specific contextual setting of R&D alliances influence both the operational work as well as certain requirements put on operational leaders, this paper contributes to an increased understanding about the R&D alliance work system.

Findings in this paper provide indications to how individuals could be prepared and trained in order to better meet the challenges in specific alliances that could therefore reduce the risk for human resources consumption. Although based on a small sample, which calls for more thorough investigations into these matters, the paper highlights issues of both regeneration of human resources and performance related to specific alliance contexts. This could be important in order to further understand R&D alliances as sustainable work systems.

PAPER 4

Title: R&D Alliances: Operational and Top Management Challenges for HRM

Author: Lars Uppvall

The Purpose and Main Findings of the Paper

This paper aims to contribute to the understanding of how Human Resource Management (HRM) could support the operational work in R&D alliances. The role of HRM in relation to the alliance operation is limitedly described in the literature: both in the area of HRM and alliance management. However, past alliance research emphasizes that the “human factor” is critical in the alliance operation. Since HRM plays a central role in terms of achieving competitive advantage through the organization’s human resources, an increased understanding of how HRM could support an R&D alliance operation is important for operational performance, as well as for a company’s ability to conduct collaborative strategies in product development.

After reviewing the emerging literature on the role of HRM in inter-organizational relationships, a basic framework was developed that consists of five central themes that have been theoretically addressed in the literature related to a HRM perspective on alliance management on the operational level. These themes are: the selection of the alliance partner, the staffing of the alliance project, the cultural fit between the partners, alliance management skills, and top management commitment. The 158 critical incidents were analyzed and categorized according to the five themes in the developed framework.

The most noticeable results from the analysis have been the nonexistence of references to HRM in any of the 158 critical incidents or in the interview data as a whole. However, the analysis of the critical incidents from a HRM perspective related to the five themes indicated both a strong need for, and a high potential of, increased attention to HRM in alliance operational work. According to the aim of the paper, the findings from the analysis were summarized in a proposed framework describing HRM-related tasks and direct HRM participation in support of R&D alliance operations. Since the engagement in inter-organizational product development is an activity where strategic decisions and operative consequences are particularly interconnected, the support from HRM in this area relates to both top management and the alliance operation. In short, the results indicate that HRM tasks that related to the support of the alliance operation includes the following: training (such as the development of new roles and responsibilities, the handling of strategic information, and the consequences of cultural differences); screening of “suitable” candidates for future staffing of alliance projects; and, assisting in the development of alliance-related processes and work routines. Direct participation from HRM in the alliance operation could relate to initiating informal and social activities,

staffing and re-staffing of the alliance project, as well as offering direct support for operational leaders in particularly challenging situations (such as major renegotiations of alliance contract). The findings related to the top management level indicate that HRM's task in supporting the alliance operation could be achieved by the increased training for executives and higher management in areas, such as corporate cultures (i.e. having a greater understanding of one's own and potential partner's respective cultures), the information needs in the alliance operation, and a redefinition of risks and opportunities related to decentralization of strategic information. HRM's participation as it relates to the top management level could incorporate the direct support in screening potential partners e.g. related to cultural and work practices, the initiation of top management interaction in critical situations of the alliance project (in order for increasing motivation), and to support initial decisions related to the scope of R&D alliance projects, or a adjustment of scope (e.g. based on skills and work practices of the company's human resources).

In conclusion, the paper shows that HRM represents important, yet neglected support for the R&D alliance operation. The findings in the paper particularly contribute by identifying the need for specific support from HRM related to critical situations in an alliance operation; this could be an important aspect in the work of increasing the operational performance in R&D alliances.

The Contribution to the Thesis

HRM plays an important role in the development of skills and capabilities so that individuals can handle increased responsibilities and complexity in less formalized work systems. The suggested tasks and direct participation of HRM that relates to the organization's alliance activities in this paper, therefore, contribute to the understanding of how HRM could support both the regeneration of human resources and the performance in R&D alliances.

DISCUSSION

This chapter begins with a discussion related to the first research question. The discussion here is based on the results from the four appended papers; it follows the five themes of the modified phase-based framework that was presented in Paper 1. The results are then discussed from the sustainable work systems perspective, focusing on the second research question. Conditions for regeneration of human resources in R&D alliance work are first discussed according to Antonovsky's (1987a,b) concept sense of coherence. Then, four principles to support work in R&D alliances from a sustainable work systems perspective are introduced and discussed. These are adapted from the three organizational principles for innovation in product development, presented by Dougherty (1992a), along with an additional principle related to support systems for sustainable work. The second research question will, therefore, be answered through synthesizing the overall results from all papers in a sustainable work systems perspective.

CHALLENGES AND OPPORTUNITIES IN THE R&D ALLIANCE WORK SYSTEM

The outline in this section relates to the five themes of the phase-based framework presented in Paper 1, and shown in Figure 9.

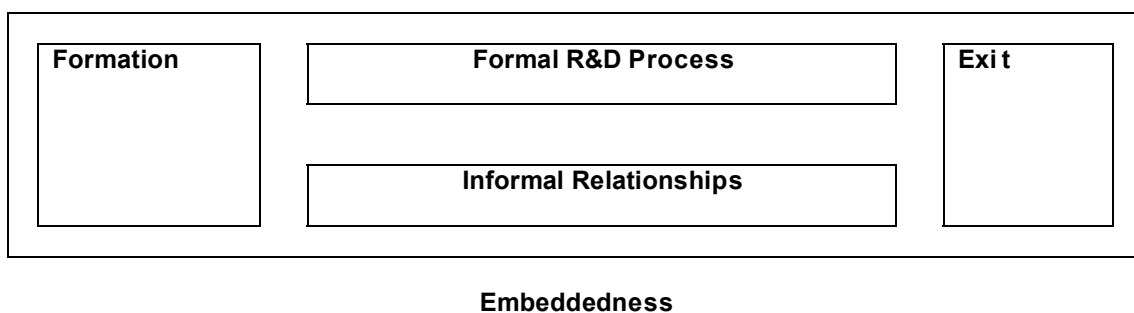


Figure 9. Phase-based framework for R&D alliance operation.

Operational leaders in the R&D alliances operations, who brought with them direct experiences and good insight into this work, identified the critical incidents in this study. Their roles stretched from engineers with (e.g. an object leader role) who were responsible for parts of the alliance product development, to alliance managers who were responsible for the entire alliance project. As such, the results highlight the details of how critical situations were practically managed; an area of particularly need for empirical illumination (e.g. Doz 1996; Salk, 2005). In each of the appended papers, different perspectives of the R&D alliance operation have been analyzed. The focus in this part of the discussion is on challenges and opportunities on the individual level in the R&D alliance operation.

Hence, the following discussion relates the findings in all of the appended papers to the first research question:

What do challenges and opportunities, as reflected in critical incidents in the R&D alliance work system, imply for operational leaders?

Managing the Formation of R&D Alliances

The formation of alliances is only seldom studied on an operational level. A few exceptions have examined the formation as a phase in the alliance developmental process (e.g. Ring and Van de Ven, 1994; Doz, 1996; Ring 2000). In terms of operational aspects of the initial stages in R&D collaborations, the studies of Doz (1996) and George and Farris (1999) are two of the few contributions. Both of these studies underline the influence of the initial stages on the performance of R&D alliances. Although limited in operational details from the initial work, Doz's study points to such issues as the initial neglect of joint learning and an underestimation of the complexity of the subsequent R&D work that leads to severe problems in later stages of the relationship. George and Farris (1999) conclude that "soft" criteria and data regarding compatibility of the partners are often neglected in the partner selection work. Moreover, they stress quick feedback and reactions from any anticipation of problems during the early parts of the relationship.

The partner selection criteria in Paper 1, such as product and market experiences, were found to be important. Another critical criterion was related to earlier cooperation and/or existing personal networks between the companies - similar to pre-alliance network ties - as per Gulati (1998). However, decisions to select a specific partner have been mainly seen as a top management issue (e.g. Doz, 1996; Gulati, 1998; George and Ferris, 1999). A contribution from this study is the incidents related to *go* or *no-go* decisions in the partner selection - also on the operational level. These results show that in the pre-contractual "dating phase" actions and behaviors of individuals could determine the selection or rejection of a partner after only a brief first meeting; this is based on an immediate focus on both skills and trustworthiness. When successful, these meetings allowed technical skills and product functionalities to be displayed from both partners as well as a mutual understanding of risks and problems, as shown in Paper 2. In contrast, overlooking a technical issue, thus, indicating a limited understanding of, or concern for, a partner's view of the product functionality, could lead to rejection. In addition, in order to be credible in understanding the partner's situation, individuals representing the organization must acknowledge issues related to equality (Ring and Van de Ven, 1994).

For example, a less powerful partner will carefully monitor statements related to power (such as relative size of respective partner or technical domination in an industry).

Furthermore, a critical step in the alliance formation was the formulation of the alliance contract. In line with prior literature (e.g. Ariño *et al.*, 2001), time that was given to face-to-face meetings, openness, and effort allocated to this task were found to be critical in order to cover a sufficient amount of learning between the partners: including a detailed understanding of technical, operational, and cultural aspects. Such negotiations support the coming operational work by both well-formulated paragraphs and a better mutual understanding of how to interpret the contract (if it were to be renegotiated). This, however, is not equivalent to saying that thorough contractual negotiations should result in a “clear-cut” agreement (e.g. Sivadas and Dwyer, 2000). In line with, for example, Ariño and de la Torre (1998), our results show that it is unlikely the formulations could foresee the complexity and the uncertainties in the coming work. Therefore, it is important to formulate a contract that should support a mutual interest and not become a means for one partner to take advantage. However, different contract strategies were revealed that supported a mutual view (as addressed in Paper 3). Examples were found of both informal strategies (where a trust-based contract gradually replaced the formal contract) and a more formal strategy (based on contract formulation that incorporated “exit points” in the coming alliance process, where the partners could end the collaboration if an unfavorable situation had occurred). On the contrary, specific and rigid contracts lead to negative effects in the coming operational work. The most demanding situation had its origin in a specific contract formulation, which incorporated an advanced payment agreement. This was intended to work as an incentive for streamlining the interests of the partners, as related to institutional-based trust formation in Paper 2; however, this resulted in a situation where one partner tried to take advantage of this formulation by manipulating the operational work process. Therefore, how the alliance contract is formulated and how the contract negotiation is managed could lead to both a foundation for good operational work conditions, as well as severe challenges for the individual in R&D alliances.

Lastly, only a few incidents indicated that the overall organizational setup, referred to as governance structure, was critical to the alliance outcome. One example related to the negative effects from one partner that sorted the R&D alliance under the company’s marketing function, which highlights the importance of having a direct and close integration between individuals in the operational work.

Hence, these results support earlier research that show the importance of initial work and contract negotiations for the outcome of an alliance (e.g. Doz, 1996). However, the focus on the operational level also shows complementary findings. Initial meetings will most likely represent unfamiliar work situations for individuals on the operational level. Both technical and social skills will be put to test, where only a minor individual misjudgment will carry the potential of large strategic consequences for the firm. For example, if rejected by a specifically important partner or if poorly executed initial work leads to low alliance performance. As a consequence, both managers as well as HR-functions should pay particularly detailed attention to the staffing of initial meetings on operational level (as discussed in Paper 4). These results indicate that prior studies focusing on the top management level have lead to neglecting the importance of - and the strain upon - individuals (such as operational leaders, in the formation of R&D alliances).

Managing Formal Processes in R&D Alliances

Coordination of actions in alliances is claimed to be particularly difficult due to absence of hierarchical structures and systems available within organizations (Gulati and Singh, 1998). Taking into account the amount of coordination that is needed in order to integrate different functions in product development within an organization (e.g. Cooper, 1993; Brown and Eisenhardt, 1995), R&D alliances could be even more challenging to coordinate. Based on a large-scale survey, Sivadas and Dwyer (2000) compare factors affecting internal versus alliance-based product development; they found an increased cost in coordination and decreased success rates for alliance-based product development. However, research is limited in how coordination obstacles are overcome in the operational R&D alliance. Doz (1996) gives some examples of how difficulties related to formal structures and processes in the operational work can have serious effects on the outcome of joint R&D. The results illustrate that formal structures and process coordination in the operational work are related to great efforts and the willingness to let go of one's own internal routines in order to succeed.

According to Paper 1, the integration of formal R&D processes revealed several operational challenges. Particularly, coordination of the partners' product development processes and work routines created obstacles in the work, based on differences in how these were interpreted and understood. Issues concerning levels of details, methods for specific tasks involved, and so on negatively affected the collaborative work. Generally, formal product development process models tended to be more similar on paper – and in the eyes of an alliance partner – than when comparing how the product development work was actually conducted. Formal process models have been questioned, in terms of giving effective support on the individual level in less formalized work systems concerning single firm product development (e.g. Engwall *et al.*, 2005). Our results support arguments for such limitations of these models (i.e. from not being sufficiently related to work practices when applied to coordinate the joint work between two firms).

Moreover, to compensate for the uncertainties in the R&D alliance work, some partners tried new methods for increased interactions to enhance performance in the project (e.g. to use sketches sent by fax before transferring specifications into formal drawings). However, such new or changed formal work routines seemed to be difficult for some individuals to adopt. When differences existed in the ability to adapt work routines and processes, great tensions were created in the operative work. In some organizations, individuals seemed to be more tied to their formal routines, which have also been shown to increase the reluctance to commit oneself to collaborative work in joint ventures (Doz, 1996).

In terms of the different stages in the product developing process, work related to concept development and pre-production stages seemed to be especially challenging. In several alliances, only one of the partners possessed comprehensive knowledge regarding the application context for the final product (e.g. as illustrated in Paper 3, where one of the biotech projects was related to highly specific end-customer requirements). When concept designs should be mutually agreed upon, the innovativeness and technical skills of one partner were sometimes weighted against the specific customer requirements that were only familiar to the other. Such third-party requirements (often linked to detailed aspects of a customer's operation) seemed to be difficult to communicate. Therefore, negotiations concerning how to prioritize and evaluate related trade-offs in the conceptual

design lead to conflicts. Moreover, the difficulty to communicate these aspects lead to overlooked requirements in planning, as well as non-mutual understanding of contract formulations; this resulted in conflicts regarding design changes. Examples were given where such decisions had to be forced rather than mutual agreed upon, meaning that sometimes the entire collaboration was put at risk.

In the pre-production stage, critical incidents reflected similar situations that are commonly described in in-house product development: for example, related to the verification and production planning (e.g. Wheelwright and Clark, 1992), although the complexity in the coordination of the alliance project meant that these issues were harder both to anticipate and to solve. Moreover, testing the final product once again showed problems related to customer requirements. Methods for testing are highly related to the requirements of the application context. In terms of work routines and procedures, testing appears to rely on tacit knowledge that was too difficult to transfer and, therefore, for the results from testing to be trusted between the partners. Incidents directly related to knowledge management in Paper 1 also confirm these aspects by showing positive incidents from an overlap in knowledge; a partner's possession of specific tacit knowledge, on the other hand, is hard to confirm prior to the joint operational work, which should be considered in the planning of an alliance.

Hence, coordination of formal processes and work routines between partners in R&D alliances is related to great tensions in the operative work. Formal structures and process models will not give the same support for the individual when the partners interpret them differently and they risk becoming contradictory in terms of work practice. Not only does collaborative R&D work force operational leaders to let go of some of their own organization's routines and processes, they will also have to negotiate less explicit requirements (e.g. from their customers) in order to find mutual accepted solutions from the continuation of the alliance operation. Therefore, in line with e.g. Doz (1996), these results show that shortcomings and contradictions in formal processes and work routines require individuals who are willing and able to search for new and effective routines.

Managing Informal Relationships in R&D Alliances

The importance of informal relationships has been widely recognized in alliance literature. In research taking a dynamic perspective on the alliance process, the creation of interpersonal relations and trust is frequently seen as a necessity in the absence of formal structure and control (Ring and Van de Ven, 1994; Doz, 1996; Ariño and de la Torre, 1998). However, questions regarding how the action and behavior of individuals have an influence on the operational work have been left rather unexplored (e.g. Salk, 2005). Again, exceptions are mainly the case studies of Doz (1996) and Ariño & de la Torre (1998). However, even though Doz, for example, includes "front-line" day-to-day leaders in the studied R&D collaborations, much of the discussion covering the informal relationship focuses on the views of executives and senior line managers.

This could be the most critical aspect for operational leaders to handle, from the perspective of the high number of critical incidents related to the theme of informal relationships (40% of all incidents), as presented in Paper 1. However, due to the majority of positive incidents, the management of the informal relationship also offers opportunities: where individuals can directly influence the relationship, their work, and the success of the collaboration.

The actions and behaviors of any individual in the R&D alliance operation proved to have a direct and strong influence on the relationship and, therefore, on the outcome of the projects. Most decisive were actions and behaviors that either contributed to a *forward momentum* or as *defensive actions* in the alliance operational work. This was also true for those related to *politicking*, where specific actions were understood as attempts to manipulate the alliance work in one party's interest.

For the alliance relationship to grow and support the operational work, individuals had to tackle upcoming situations with the alliance progress in mind. This was mostly done by taking the initiative in combination with openness and accuracy regarding how these actions related to the agreed upon progress and outcome of the R&D alliance. For example, crucial for operational leaders were having the ability to pay strong attention and show adaptation to a partner's situation or culture, being utterly clear concerning one's own intentions and position, to show dedication by doing, and altering one's own agenda to accommodate the partner in critical situations. This requires a comprehensive understanding of the partner's situation (and how this changes over time), as well as the ability to clearly communicate one's own motives and actions. Conversely, not acting and behaving proactively was highly negative for the relationship and hindering progress. Such incidents concerned repeated mistakes without having the ability or willingness to learn, or making defensive statements concerning time plans and one's own ability. It is, therefore critical, to be realistic about one's own ability to learn, but also constructive when faced with unexpected situations. However, a partner that acted opportunistically for non-mutual gains was shown to put the whole collaboration at risk. Therefore, attitudes and behaviors in all parts of the collaboration must be carefully considered from the perspective of the mutual relationship; anyone's initiative to "make a deal" in the alliance operation must be measured against the cost of a total termination of the collaboration.

Managing Informal Relationship as a Matter of Managing Trust

These strong reactions are related to the need to trust your partner in situations with less formal control. Since uncertainty and lack of formal control are inevitable in alliances, trust has been frequently appointed as a fundamental managerial aspect (e.g. Parkhe, 1998a,b; Das and Teng, 2001b). However, few studies have examined how trust is formed on an operative level in alliances (Ring and Van de Ven, 1994; Planander, 2002).

A framework describing trust formation was developed in Paper 2 based on the work of Parkhe (1998b) and Zucker (1986). The framework consists of three categories of trust formation mechanisms: process-based, characteristic-based, and institutional-based. These were applied on the critical incidents to analyze how trust was formed in the operative work in R&D alliances. The overall findings showed that a majority of the incidents were related to these three mechanisms. As such, these mechanisms represent key issues for operative leaders to master and, if managed well, they also represent important support for individuals in the R&D alliance work. The process-based mechanism is related to a consistency in behavior over time in the collaboration. The actions and behavior of a partner will be constantly matched against what is expected; if matched according to the other's view, this will strengthen the trust formation. The challenge for individuals, however, is to understand the view of the partner and their view of particular risks, etc. To be consistent, to deliver what was agreed upon, and to show results in areas that had

been put forward as one's own strength, were all important aspects of positive trust formation. With less formal routines to rely on, this also implies a greater focus on informal communication regarding a give-and-take balance over time between the partners. Nevertheless, when unexpected situations occur, risks will often be in focus. There will then be high expectations on a mutual adaptation in order to reach the alliance goals. Behaviors in these situations perceived as not matching an expected mutual contribution were shown to instantly reduce the level of trust (e.g. the unwillingness to change plans or become insecure in one's own capabilities).

Furthermore, differences in culture have been appointed as a hindrance for trust formation, by limiting the communication and mutual understanding between the partners (e.g. Ariño *et al.*, 2001; Parkhe, 1998b). In particular, national and corporate cultural differences have been addressed (Parkhe, 1991). Selecting a partner with a similar national background would, therefore, limit the risks related to differences in national cultures. Findings in Paper 2 that relate to the characteristic-based mechanism could complement this view of prerequisites for trust formation. In line with prior research one of the alliances showed positive effects of choosing a partner with a similar national culture. In other alliances where there were large differences in national cultural (e.g. between a Swedish and a Japanese partner), these differences were found to demand extra attention; this also required extra resources in the operational work (e.g. terms of adoption to social norms and values). However, adaptation to national cultural differences was found to be critical, but were also successfully managed. In general, the national cultural differences seemed to be detectable and, by overcoming them, trust was actually increased. Conversely, corporate cultural differences seemed to be difficult to detect and particularly complicated to handle in the operative work. When given less attention, they often become first apparent when they resulted in mistakes. Situations were very challenging when partners had to re-evaluate their view about each other and how to manage the joint work. Therefore, it seems to be important for successful collaborative product development to evaluate both national and corporate cultural differences, in terms of how they will affect the operational work in a specific alliance (in particular, addressing and understanding one's own company's corporate culture, the implications it has on one's own work practices, and how these aspects could differ from those of a specific partner).

The third institutional-based trust formation mechanism related to building trust through formal mechanisms (e.g. by non-recoverable investments or punishments for cheating) was only related to a few incidents. The greatest challenges in the operational work were found to stem from the aforementioned contract formulation, which included an advanced payment system. These incentives were intended to promote collaboration and efficiency. However, by being built on predictions of future state of being, the consequences turned out to be complex to handle and create severe tensions in the operational work.

In order to promote trust formation, the greatest challenge for individuals lies in understanding both the partner's situation and work practices in order to act consistently and predictably. Identifying and overcoming differences demanded informal integration (e.g. through frequent face-to-face meetings with open sharing of information).

Moreover, shifts in the level of trust between the partners is highly related to the complexity of the operational work and the outcome of the alliances. As indicated in

Paper 3, conceptual models of trust may not reflect how trust is created on operative level: for example, when trust is differentiated into competence trust and goodwill trust (Das and Teng, 2001b). Due to the dependence on each other's resources and competence in solving complex and unpredictable problems, it seems unlikely that partners could have low competence trust and still have high goodwill trust.

The results indicate that accomplishing a good relationship requires great attention from operative leaders on behavior and actions in the operative work, when looking at the alliance relationship and how it was managed in critical situations. The results should be seen as a contribution to alliance research by showing the critical influence on performance from the behavior of individuals in the practical work. Data gathered on the executive level would probably not uncover the details of such issues and the challenges for operative leaders in this type of work. In particular, to master the mechanisms of trust formation analyzed in Paper 2 could be a key competence for operational leaders.

Managing the Embeddedness of R&D Alliances

According to earlier research, the best way of understanding the challenges in alliances might not be to focus only on the dyadic alliance relationship (e.g. Khanna, 1998). In the case studies by Doz (1996) and Ariño & de la Torre (1998), issues related to how the alliance was embedded in the two organizations influenced the alliance process: for example, the interactions of middle management in the partner organizations with potential conflicting interest (Doz, 1996). However, operational aspects of the embedded nature of R&D alliances and consequences on the individual level are still rather unexplored.

The alliance embeddedness showed the highest proportion of negative incidents, according to the analysis in Paper 1. The alliance operation directly relates to several functions in both of the partner's firms, their suppliers and customers, as well as the strategies and top management agendas. Adopting the product development work to the alliance will result in both new interactions (e.g. related to other functions in the partner's organization), as well as some altered conditions for already existing interfaces (e.g. relationships with other functions in one's own firm). Comprehending the alliance embeddedness and simultaneously mastering the complex alliance relationship seemed to be particularly contradictory on the individual level.

For operative leaders, it was difficult to predict and prepare the R&D alliance for the interactions from other functions in their own firm. In some situations, for example, the purchasing or marketing functions participated in the alliance planning process, but changed role or attitude toward the partner during the alliance operation. This was highly negative for the informal relationship. Another example was related to personal consequences for an alliance leader when bringing perceived poor documentation from the alliance partner into the more formal project processes in his own company. These examples typically show that the challenges from the R&D alliance operation are not only a matter of the direct interface between the partners. Individuals must manage and bridge several influential interfaces.

Moreover, strategic agendas were also shown to be hard to handle. For example, changes in product strategies (e.g. changes in produced volumes of the final product) were sources of conflicts. These changes often affect the experienced equality in the shared work. Since the basic idea to create an alliance is to accomplish strategic benefits for both partners,

these types of changes influenced the relationship in a deeper sense and the foundation of the whole collaboration. Therefore, this could strongly influence the give-and-take balance in the relationship; operative leaders must handle these changes even though they are not directly responsible for initiating them. The results in these situations show examples where individuals were poorly informed about strategic issues and received the information too late in order to be able to manage the alliance relationship in an effective way.

Additionally, the embeddedness of the R&D alliance relates to the strategic context of the partners (e.g. characteristics of the specific industry or how strategic knowledge could be protected). Strategic context of alliances has been shown to influence the operational work (Doz, 1996). The analysis in Paper 3 showed similar results, where the differences in strategic risks in connection with specific projects seemed to influence the type of issues that caused critical incidents. Therefore, operational managers should be prepared to meet specific type of challenges in their work that relates to the strategic context. For example, if risks are perceived to be high in terms of the alliance project influencing the strategic position of one's own company, then managers should be particularly well informed about details regarding which issues influence the company's strategic position and how these should be communicated in the alliance operation.

Thus, a highly challenging issue appears to be how to handle the alliance operation in relation to the rest of the companies' organization and specific context. Therefore, viewing the alliance project as an open work system that addresses all interfaces that must be managed in order to accomplish the alliance output, may be a better approach for understanding the challenges put on individuals, than by only focusing on the direct interface between the partners. Clashes between interest among individuals and between formal processes related to other parts of the collaborating partners' organizations, caused large amount of pressure on the individual level. Finally, limitation in access of strategic information was shown to be a critical obstacle for operational leaders in order to predict and manage the alliance relationship.

Managing the Exit of R&D Alliances

The termination of an alliance has often been equated with some sort of failure or low performance (e.g. Ring and Van de Ven, 1994). This view may not be relevant in terms of R&D alliances, due to the planned timeframe of most R&D projects, which could also be true for other types of alliances (see, for example, Gulati, 1998). Hence, critical incidents related to the exit phase did not automatically refer to a poor relationship or unfulfilled goals. Only three negative critical incidents concerned the alliance exit (e.g. related to a change in product strategy). Positive examples were related to efficient information exchange in the dissolution of the project. However, more research is needed in order to further understand how the dissolution of different types of alliances are managed and what are the consequences on the involved organizations according to how they end. Important issues concerning product development that would complement our findings could be following: how the ending and evaluation of R&D alliance projects relate to subsequent collaborations between the partners for a next product generation; decisions to select an alternative partner; or the choice not to use this type of product development collaboration in the future.

In conclusion, the discussion related to the first research question reveals insights into several specific areas of R&D alliance operational work. This must be seen as an important contribution to the alliance research where these aspects are often treated as a “black box” (e.g. Ring, 2000; Salk, 2005). According to the five themes: Formation, Formal R&D processes, Informal relationships, Embeddedness and Exit, R&D alliance work is associated with great complexity that brings operational leaders both challenges and opportunities. As shown, this work puts high demands the individuals’ social and formal competences and their ability to take initiatives in work. However, as with most post-bureaucratic work, such abilities are context specific and relate to local work practices for which these results contribute with rare examples in the specific case of R&D alliance work. Moreover, the complexity also relates to high work intensity and the risks for human resource consumption. Hence, considering the growing number of created R&D alliances, the reported high failure rates for this type of collaborations, and the risks of high work intensity in this work, it seems particularly important to increase our knowledge regarding R&D alliances as sustainable work systems.

IMPLICATIONS FOR SUSTAINABLE WORK IN R&D ALLIANCES

In this section, the results will be discussed adopting the concept of sustainable work systems in order to address the second research question:

What implications do these results have on R&D alliances as sustainable work systems?

First the regeneration of human resources will be addressed based on the experiences that individuals face in critical situations in the R&D alliance operation. Regenerative work is one of the fundamental aspects of sustainable work systems and will be discussed according to Antonovsky’s (1987a,b) concept of sense of coherence. The findings will then be discussed from a sustainable work system perspective, citing literature on alliances, product development, and post-bureaucratic work.

Consuming or Regenerative Work in R&D Alliances

Companies need to be competitive based on work conditions that regenerate the deployed human resources in order for them to be sustainable (Docherty *et al.*, 2002a). Building on Antonovsky’s (1987a,b) concept of sense of coherence, Kira (2003) suggests that regenerative work should be comprehensive, manageable, and meaningful - taking into account the individual’s needs and values. An individual’s sense of coherence is dependent on different kinds of generalized resistance resources (individual, material, social, and cultural). With a high sense of coherence, an individual is able to mobilize generalized resistance resources that are needed in order to experience, for example, a new work situation as comprehensive, manageable, and meaningful. Since regenerative work in less formalized work systems cannot easily be defined (in terms of expert designs or organizational prototypes), it must be found through studying local practices and processes where people and work interact and consequences of regeneration could be determined (Kira, 2002). Based on this view, critical incidents in the operational work of R&D alliances represent a source of information where one can find the regeneration or the risks of human resource consumption (e.g. related to individuals’ experience of sense of coherence).

Comprehensibility in R&D Alliance Work

Comprehensibility must be deemed as challenging for the individual in alliance work, as reflected in the themes of formal R&D processes and embeddedness in Paper 1, where there is a high probability of facing demanding situations that are related to comprehensibility. For a work situation to be comprehensive, individuals need to receive ordered, consistent, structured, and clear information (Antonovsky, 1987a,b). When product development work spans the boundaries of two organizations, work tasks will become interdependent with increased complexity and uncertainty as a result; this will be difficult for individuals to comprehend. Several specific aspects of the R&D alliance work seem to endanger regenerative work and increase the risk for human resources consumption through lack of comprehensiveness.

Formal process models are important cognitive tools in product development in order to understand workflows and for the coordination of different tasks (e.g. Engwall, 2003b). However, limitations in these models showed, for example, in terms of not supporting a shared understanding of specific work practices when applied to coordinate and comprehend product development between two organizations. Complexities in the R&D alliance work frequently emerged from unexpected differences in idiosyncratic work practices in the partner organizations. Critical incidents relating to such situations consumed energy and enthusiasm among the individuals involved. Experiences of comprehensibility were reduced both by the increased complexity in the coordination of the time and process-focused product development and from increased concerns regarding potential future misunderstandings related to the partner's work practices and mismatches of work processes.

Furthermore, due to the complexity and uncertainty in R&D alliance projects, the interrelationship with other functions in the partner organizations become more difficult for individuals to comprehend. Such situations - where the mother organization's formal structures did not support the informal work - have been described as creating a confusing work situation with the potential to consume human resources (Hage, 1995; Kira and Forslin, 2008).

Apparently, having very open attitudes regarding information sharing and prioritizing resources to increase face-to-face communication were critical to reduce complexity in the R&D alliance work. This can also be related to sense making processes (Weick, 1995), which are seen as a collective activity contributing to both the ability to communicate and establish joint contextualization. If R&D alliances are managed with resources that promote rich communication and, thereby, sense-making processes (Weick, 1995; Ring and Van de Ven, 1994) the outcome may result in a more coherent and sensible world with increased comprehensibility for the individual. However, achieving comprehensibility could be difficult and, therefore, represent a specific obstacle for the regeneration of human resources in R&D alliance work, considering the high ratio of negative critical incidents in relation to formal R&D processes and embeddedness, as per Paper 1.

Manageability in R&D Alliance Work

For a work situation to be experienced as manageable, the individual needs sufficient resources in order to cope (Antonovsky, 1987a,b). In less formalized work settings, manageability is particularly demanding due to high demands on the individual's

competence and the resources available in order to achieve collaborative work. Manageability relates to both formal and informal social structures. Individuals need to trust formal social structures and that these offer environments and equipment that are appropriate to the work situation. For example, trusting that other individuals are doing their work properly is a prerequisite for a manageable work situation. Informal social structures are also important: for example, the sense of manageability will increase by collaborative contacts with others, as well as through the knowledge that there is social support available if and when something goes wrong (Kira, 2003).

Informal relationships and trust in the R&D alliances were shown to be crucial for manageability. In well-functioning informal relationships, partners could trust in each other's contributions to the R&D alliance project, despite the lack of structure and control. If mistakes were done, a trustful relationship enabled joint actions and solutions without conflicts. Several respondents pointed to the presence of trust as the most important aspect of managing the collaborative work. However, achieving a trustful alliance relationship is associated with great efforts, in terms of learning and social interactions between the partners. This could be exhausting and, therefore, threaten the regeneration of human resources in the long term in trustful relationships as well. In R&D alliances with problematic informal relationships, where the trust was low or had decreased through conflicts, work situations were described as extremely difficult to manage. Mistakes or low quality of work from a partner were not met with constructive solutions. Instead, it triggered discussions and disputes about responsibilities (e.g. checking details in documents in the history of the project), which drained energy and created frustration. Therefore, trust is highly important for manageability and, thus, the regeneration of human resources in R&D alliance work. However, succeeding in jointly developing new products based on personal relationships and learning about each other, was shown to be personally rewarding. In this sense, an R&D alliance can contribute to great opportunities for individuals to grow and create resources in order to cope with demanding situations in the future. Conversely, the absence of trust is a great risk for human resource consumption by creating situations where individuals' ability to achieve manageability through collaborative effort will be dramatically reduced.

The complexity and uncertainty in the alliances showed that plans and work routines often had to be changed due to the interdependence of the partners' work. Individuals in such situations need resources and support to adjust their own work practices. For example, being confined to one's own organization's formalized administrative procedures for documentation and work routines was negative, in terms of manageability due to high demands for flexibility and a need for frequent iterations.

Hence, it is important to ensure manageability in R&D alliance work. However, high demands will be set on individuals' social skills, as well as formal competences. Even in well-functioning alliance relationships, achieving trustful relationships across organizations could consume more energy from individuals than what is needed to accomplish manageability in in-house product development. This may, therefore, be negative for the regeneration of human resources in the long term. R&D alliances without established informal relationships must be seen as direct risks for resources to be consumed. However, by being forced to rely more on informal social structures, this type of work might also provide opportunities for individuals to grow and develop new resources that are important for them and their companies.

Meaningfulness in R&D Alliance Work

Meaningfulness relates to the extent to which an individual senses that the demands met in work are worth her/his time and energy and s(he) will, therefore, put forth an effort to execute the work (Antonovsky, 1987a,b). This also requires an understanding of the whole work process in order to experience a meaningful connection. In addition, meaningfulness relates to a sense of joy and pride regarding work: both from one's valuation, as well as how society assesses the work and the work organization (Kira, 2003).

Several of the critical incidents indicated a strong appreciation of personal efforts related to the informal aspects of the R&D alliance work. Overcoming obstacles in the complex work setting - where structures and work procedures offer less answers to emerging problems - seemed to enhance the perceived importance of individuals' contributions and meaningfulness in the R&D alliance work. Moreover, in well-functioning relationships between partners with large differences in national culture, the extra effort to overcome these differences was rewarding, and brought meaningfulness to the joint work. However, the achievement of meaningfulness in R&D alliance work always demands social and collaborative skills and extra personal efforts.

Issues of low meaningfulness were also indicated in the study. For example, in an alliance where a part of a product system were co-developed with a former supplier, questions were raised whether all the perceived extra efforts made in the collaboration were worth the gains compared to buying the parts that the partner developed alone. Generally, the results indicate that when the informal relationship between partners was troublesome, then meaningfulness in R&D alliance work could be rapidly reduced due to the extra burden in terms of complexity and great efforts related to collaborative product development. Therefore, it is important to communicate to the individuals in the operative work, the overall strategic gains that often motivate the decision to form an R&D alliance. Individuals could then find meaningfulness in their work through the connection to the company's future success. For example, the described situation where the CEO of a large company attended an alliance project meeting to personally inform others about the strategic importance of the product developed in the alliance for the future of the company.

Thus, the results indicate that the R&D alliance work setting could have a leverage effect on meaningfulness for the individual. That is to say, complexity in work from inter-organizational interdependence and cultural differences imply considerable personal input. Overcoming these obstacles by exposing oneself to unfamiliar work situations were expressed as particularly rewarding and meaningful. However, when the alliance relationship was problematic despite large individual efforts, the meaningfulness of this work could be particularly low.

In conclusion, individuals' experience of a high sense of coherence in work enables them to deal with stressors in complex work systems (Backström *et al.*, 2002). Therefore, if work systems support individuals in order to experience work as comprehensive, manageable and meaningful, then they will also be able to learn and grow from these experiences – and work becomes regenerative. Opportunities of regenerative alliance work stem from open attitudes and face-to-face communication in order to achieve comprehensibility throughout organizations with differences in work processes and

routines. If a trustful relationship is accomplished, then this will increase the experience of manageability for the individual. In such relationships, meaningfulness could also be high and, therefore, R&D alliance work could be regenerative. However, similar to other types of less formalized work systems (Docherty *et al.*, 2002a; Kira, 2003), this discussion demonstrates that the opportunities of regenerative work in R&D alliances is difficult to manage, and will require new resources and skills on the individual level. For example, a trustful relationship could easily be damaged; if trust is broken, then the results indicate that there will be direct risks of human resource consumption. Therefore, the R&D alliance as a sustainable work system will be discussed in the next section: how this type of work system could support both the regeneration of human resources and the competitiveness of the organization.

Principles for Sustainable Work in R&D Alliances

Achieving sustainability in less formalized work systems is a challenge (Hage, 1995; Docherty *et al.*, 2002b). Important aspects of competitiveness in product developing companies are the ability to innovate in combination with an effective use of resources. Reported consequences of these aspects are companies' adoption of more integrated and flexible approaches in product development work, as well as an increased engagement in inter-organizational partnerships: such as R&D alliances (e.g. Olin and Shani, 2003; Narula and Duysters, 2004). Since these approaches often imply more personified jobs for highly skilled individuals - both technically and socially (e.g. Ring and Van de Ven, 1994; Docherty *et al.* 2002a; Kira, 2003) – competitiveness and the regeneration of human resources in R&D alliances could be seen as different sides of the same coin. Therefore, in order to be sustainable in the long-term, product-developing companies must balance trade-offs related to challenges and opportunities in less formalized work systems that supports innovation, inter-organizational relationships, and regeneration of human resources. That is, a work system where specific goals are coherent with the overall aim of the system (Deming, 2000).

Product development work has been described as intensive with specific risks of human resource consumption (e.g. Lewis *et al.*, 2002). However, less formalized jobs where people get increased opportunities to be involved, take more personal responsibility, building relationships based on trust, and so on also bring great potential for individuals to grow from work experiences (Kira, 2003). But, will the R&D alliance work be too challenging by putting too high demands on individuals' cognitive and social abilities, and formal skills, thus, putting both the company's competitiveness and the regeneration of the deployed human resources at risk? This question could not be completely answered by the present study. However, implications for different trade-offs will be discussed in relation to the concept of sustainable work systems.

The discussion will be based on four principles that aim to support innovation, inter-organizational relationships, and regeneration of human resources – and, therefore, sustainability – in the design of R&D alliance work. These principles are broadened roles and responsibilities, work as a collaborative process, decentralization of strategic information (adapted from Dougherty, 1992a), as well as support systems from sustainable work. Since R&D alliance work is informal, complex, and uncertain, the use of principles in the design of this type of work means that these principles should support individuals in order to experience work as, for example, comprehensive, manageable, and

meaningful, rather than give details of how a job or work system should be designed (e.g. Kira, 2003). Hence, these principles should support individuals to engage in the local processes, solve and prioritize tasks, negotiate responsibilities, and so on.

Broadened Roles and Responsibilities

Broadened roles and responsibilities are frequently discussed as being a direct result of less formalized or post-bureaucratic work systems (e.g. Heckscher, 1994; Hage, 1995; Mohrman and Cohen, 1995; Docherty *et al.*, 2002a). When roles are less defined, individuals have to negotiate their roles, which will set high standards on technical competence, social skills, commitment to goals, and proven past effectiveness (Heckscher, 1994; Hage, 1995). New and informal roles are necessary in alliances with a high degree of uncertainty, limited amount of formal structure, and difficulties in relation to the understanding the partner's organization and work practices (Ring and Van de Ven, 1994). Due to an increased focus on innovation, requirements on the individual have also increased in ordinary product development (i.e. from mainly focusing on technical and administrative skills, to incorporating a broader range of skills related to a more holistic view of the work process and commitment to the overall goal of the organization, etc.: Dougherty, 1992a; Adler *et al.*, 2003). For example, individuals in the operational work were given control over the product development process through responsibility for deciding about changes and continuous improvements of the process, as illustrated in the study by Olin and Shani (2003).

As shown in Paper 2, the complexity and uncertainty in the R&D alliance operation imply that trust formation between the partners must be carefully managed. However, to be perceived by a partner as acting consistently and in-line with the expectations means that several dimensions of the R&D alliance work must be understood in detail. Not only does this require a high level of cognitive and social skill in relation to communication and relationship building, it also requires a deep technical and work system-related understanding in order to evaluate the partners' abilities to act in specific situations. For example, what is the true effort, as perceived by a partner, to conduct a specific task related to the alliance collaboration? How important is a specific design criterion and what are the consequences of a changed design parameter from the partner's perspective?

The findings from the critical incidents in Paper 1 were analyzed in order to uncover operative leadership roles and how these might differ from some of the established leadership roles in innovation literature, such as the Project Leader (Elkins and Keller, 2003), the Ambassador (Ancona and Caldwell, 1992a), the Gatekeeper (Allen and Cohen, 1969), the Champion (Schon, 1963; Roberts and Fusfield, 1982), and Belbin's (1981/2003) informal team roles. Four roles were identified, encompassing new or expanded role requirements. Three of these build on evidence based on frequency of occurrence of the critical incidents: Facilitating, Finishing, and Ambassadoring. The fourth role - that of the Trustkeeper - was based on evidence from the actual behavior of a few operational leaders.

First, corresponding to the management of obstacles, mismatching processes and work routines, the role of Facilitating emerged. This role requires competences related to the understanding of one's own work system, as well as cognitive abilities to foresee how differences between the partners' formal R&D processes could influence the joint project. In practice, this also embraces how the work practices are influenced by the partners' way

of making decisions, prioritizing (e.g. related to product quality), etc. Secondly, the role of Finishing stems from the need to be consistent and match the partner's expectations. More than to engage, bring energy and push the alliance project, this operative R&D leadership role emphasizes a focus on the alliance relationship and on building trust by accuracy in delivering results to the project, as has been mutually agreed upon. Therefore, related to the informal relationship, the role of Finishing is important in order to keep the alliance together by consistent incremental delivery of results in these types of complex and uncertain work realities. Third, the expanded role of Ambassadoring originates from critical incidents in the category of embeddedness. Complexity and uncertainty demanded flexibility, which influences the interface towards the operational leaders' own organization. In addition, resources in the joint project could encourage actors outside the project to exploit these for purposes unrelated to the mutual outcome of the collaboration; this could be highly damaging to the alliance relationship if the partner discovers it. Therefore, boundary-spanning activities to integrate and/or protect the alliance project were found to be a critical role for operative leaders in R&D alliances. Lastly, some of the most challenging obstacles in the R&D alliance projects seem to require extraordinary personal involvements to be solved without larger conflicts corresponding to the role of Trustkeepers. In contrast to the first three roles, the evidence for this role is based on situations that individuals who actually carried this role describe. These individuals had the skills to mobilize resources, adopt external and internal information, and make fast decisions in particularly critical situations, by considerable technical and strategic understanding, an extensive network within the respective organization (on operational and higher levels), and strong informal power. These abilities have similarities with the role of gatekeeper as well as with some aspect of the champion role. However, the role of the Trustkeeper in an alliance was critical in order to resolve a potential threat to the project, as well as to keep - or even strengthen - the trust between the partners by becoming a trusted decision-facilitator.

Acknowledging operational leadership roles in alliance-based product development reveals several implications on sustainable work in R&D alliances. First, and inline with suggestions by Elkins and Keller (2003), the project leader role will be expanded to incorporate multiple roles if considering the uncertainties and limited possibility to pre-plan the work in the R&D alliance context. Maintaining leadership roles with an administrative character in inter-organizational product development may create severe tensions and significantly hamper efficiency in product development work: that is, without addressing, for example, the results related to the Finishing, Facilitating, and Ambassadoring roles. Moreover, important and established roles in product development - such as gatekeepers and champions - also need to be further evaluated, as related to intra-organizational contexts. In terms of the gatekeeper role, the information network and the position of the gatekeeper will be influenced in the inter-organizational context; this may imply new requirements on these individuals. Furthermore, the role of Champions has been both questioned (Bidault and Cummings, 1994) and suggested to be particularly important (e.g. Doz, 1996) in alliance-based product development. Our findings related to the role of Trustkeeper confirm the importance of individuals that, similar to the Champion, could mobilize resources and demonstrate solutions. However, the result also underlines that considerable demands for social ability will be put on this role in an inter-organizational context, in order to gain acceptance for such initiatives that are based on trust throughout organizations.

Lastly, identifying role requirements is also important in order to address regeneration of human resources for the individuals that will fulfill these roles. An individual carrying a leadership role in in-house product development may experience a low sense of coherence when exposed to work in R&D alliances that have a considerable risk of human resource consumption. An important aspect for organizations involved in R&D alliances will, therefore, be how to develop a new and broader range of skills among their employees. However, the findings also revealed many critical situations that were successfully handled, based on established informal relationships. Such results indicate that individuals in the R&D alliance operational work - at least in the short-term - also had resources in order to cope with the complexity of this work.

Therefore, individuals who receive sufficient support and have resources to cope with this work could learn new skills and grow at a fast pace. Since complexity, reliance on informal work practices, etc. seem more demanding in alliances compared to general product development, skills and resources developed in these alliance projects could be seen as a resource to enhance other parts of a company's product development (Dougherty, 1992a; Olin and Shani, 2003). Thus, increasing our understanding of new roles that relate to R&D alliances and adopting a work system perspective is highly important in order for product development companies to achieve sustainability. The four aforementioned roles for operational leaders is a first step in this work.

Work as a Collaborative Process

Collaborative efforts and joint commitments are important aspects of achieving continuous regeneration of human resources and competitive performance in less formalized work systems (Docherty *et al.*, 2002a; Moldaschl, 2002). However, high reliance on collaborative processes and openness in inter-personal relationships is also associated with personal risks. For example, demands on collaborative efforts in combination with extensive role negotiations can result in anxiousness and non-productive behaviors (e.g. Gordon, 1994). In the alliance setting, collaborative processes are often more complex due to the possibility of differences in, for example, cultural and contextual backgrounds between the collaborating individuals, as well as less known personal backgrounds, etc. In addition, divergence in organizational goals may result in the need for mutual adoption in the operative work, which will increase the complexity of alliance collaboration (e.g. Doz, 1996). The creation of trust and the testing of commitments – which is crucial for effective collaboration – will, therefore, be demanding in alliance (Ring and Van de Ven, 1992; Parkhe, 1998b). Furthermore, integrated and collaborative processes have been frequently linked to product success and product development efficiency in product development work (Dougherty, 1990; Griffin and Hauser, 1996; Olin and Shani, 2003). Collaborative processes are also critical for innovation in product development. For example, collaboration will enhance the understanding of one's own tasks in relation to the final product and the ability to combine the different pool of knowledge into the developed products (e.g. Dougherty, 1992a).

The importance of an ability to collaborate based on inter-personal, rather than formal relations, should be seen as one of the strongest results from this study (as shown in Paper 1 and Paper 2). However, it was also shown to be a particularly challenging aspect for individuals in the R&D alliance work. When detailed attention was devoted to

productive dialogues between the partners, thus, creating a mutual understanding of each other's work situations and organizations, the complexity and uncertainty in the projects could be managed by collaborative efforts. As shown in Paper 2, trust-based collaboration was often a challenging necessity for alliance performance and success; it was also associated to low performance and consumption of human resources when such collaborations malfunctioned. Openness, especially in early parts of the R&D alliances were shown in several alliances to be crucial for the creation of trust and an effective collaboration. However, openness is related to highly demanding behavior (e.g. Gordon, 1994; Hirschhorn, 1997). In addition, openness in R&D alliances is also associated with strategic risks and could, therefore, be a specifically complex aspect for the collaborative processes. For example, as discussed in Paper 2, an initiative to restrict openness between the partners resulted in severe consequences related to the collaborative process.

Furthermore, effective collaborative work processes in product development have been characterized by highly iterative manners and joint engagement in concrete tasks outside normal routines and traditional relationships (e.g. Dougherty, 1992b). In addition, the creation of actionable knowledge through mock-up models has been shown to be an important tool for effective collaboration in flexible product development processes, as well as achieving sustainability (Olin and Shani, 2003). Findings in R&D alliance work point to positive aspects from joint participation in practical work in order to overcome obstacles in the collaborative process (e.g. as reported under constructive actions related to process-based trust formation in Paper 2). However, such initiatives were also associated with negative critical incidents (such as the aforementioned example where one partner introduced sending sketches by fax in order to increase the frequency of iterations in the collaborative work). Therefore, introducing new work practices in order to promote collaborative processes could be related to specific difficulties in inter-organizational work, due to differences in terms of abilities to adapt to such initiative (e.g. regarding dissimilarities in corporate cultures, specific product development work practices, etc). This has also been shown in earlier alliance research; for example, Doz (1996, p. 77) found that unexplained mismatches in competence or perceived lack of capability to adjust could escalate into "unspeakable motives beyond the efficiency of the alliance". Therefore, an open attitude may also be complemented by ongoing evaluation concerning readjustments in scope or responsibility in the alliance to support a mutual and realistic view of tasks, competences, and learning across organizations (e.g. as indicated in Paper 3, if it shows that one partner lack some expected knowledge, a reduced scope for the collaboration could be preferable).

Lastly, from a work system perspective, individuals' ability to adapt to informal collaborative processes in the alliance project will also have consequences on how they will be able to interact with the rest of their organization. Therefore, the results indicate that other functions must adjust their organizational interfaces toward the alliance project in order to match the collaborative approach. By doing this, the nature of work can be consistent with the nature of the organization for the whole of the work system (e.g. Kira and Forslin, 2008).

In order to achieve sustainability based on collaborative work processes in R&D alliances, companies must pay strong attention to how the inter-organizational context influences collaborative work practices. Openness and trust are fundamental for collaboration in less formalized work systems and, therefore, for regeneration of human resources (Brödner

and Forslin, 2002; Kira, 2003). Extensive learning about the partners' cultures and work practices in R&D alliances, in combination with the creation of inter-personal relationships, is critical for the collaborative process. However, achieving this in a short period of time in early stages of collaboration will make strong demands on individuals' cognitive and social abilities; this risks creating high levels of work intensity. In addition, methods and work practices that enhance collaboration in in-house product development may not always be applicable in the R&D alliance contexts. Hence, focusing on collaborative work processes from a sustainable work systems perspective reveals several trade-offs that must be managed for successful inter-organizational product development. This has not been specifically addressed in prior R&D alliance literature or the emergent literature on sustainable work systems.

Decentralization of Strategic Information

There is an increased focus on strategy and its role as a key integrator in less formalized or post-bureaucratic work settings (Heckscher, 1994). Sustainability in complex work systems is dependent on decentralization of strategic information in order to support individuals' ability to take initiatives, mutually align their work, and pull in the same direction (e.g. Backström *et al.*, 2002). However, managing decentralization of strategic information through a one-way communicated rational plan does not meet the demands of organizational flexibility and local adaptation to changing environments. Therefore, decentralization of strategic information in sustainable work systems should be based on dialogue and feedback loops both between work groups and across organizational levels (Backström *et al.*, 2002). In inter-organizational relationships, strategic changes in the partners' organizations that could affect the alliance work should be explicitly communicated to the alliance operation in order to be accepted in relation to fairness and equity (Ring and Van de Ven, 1994). Strategic information is also seen as an important road map in product development literature, making it possible for engineers to find new solutions and take innovative actions in relation to the product and/or the development work process (e.g. Dougherty, 1992a; Olin and Shani, 2003).

The ability to be clear about one's own intentions and act consistently in the R&D alliance work was shown to be vital for the formation of trust and the creation of collaborative work processes. In order to achieve this, access to high quality strategic information plays an important part for individuals in the operative work (as shown in Paper 2 and 3). It is clear that not only the complexity and limited possibility to rely on formal processes and established work routines increases the need for strategic information in alliances. Divergence in strategic goals and effects from external events means that there is always the risk that one partner may not live up to their expected contributions in the collaboration. A partner in such situations may risk being accused of unfair behavior or prioritizing non-mutual aspects in the joint work – with the potential of having a severe negative impact on the trust-based operational work (see Paper 2). Although some incidents were related to attempts of cheating, the most critical aspect regarding decentralized strategic information could be seen as stemming from the need to communicate the firm's strategic goals and priorities in the R&D alliance operation in order to balance equality. Individuals who do not have the ability to communicate, for example, prioritizations and changes related to product strategies of one's own firm risk losing trustworthiness in the operational work. Therefore, this could have negative effects on the collaborative work and the regeneration of human resources. This implies in R&D

alliance operational work that individuals must not only adapt to changes in their company's strategies; they must also represent this prioritizing and take responsibility for its effect on the collaborative process. Furthermore, differences in the strategic context imply different types of strategic risks related to a specific R&D alliance. The results from Paper 3 indicate that an alliance's strategic context can influence the type of strategic information that will be critical in the operational work; this is in line with Doz's (1996) findings. For example, if the outcome of the alliance work could be easily transferred, then partners' concerns regarding their strategic position and loss of competitive advantage may result in one partner trying to restrict over the other how the results from the joint work could be used. In Paper 3, such attempts showed to have direct negative consequences on the operative work and informal relationships.

Hence, the decentralization of strategic information in R&D alliances will not only relate to the regeneration of human resources by increasing individuals' ability to handle a highly complex work environment; it will also be important in order to reduce suspicions of opportunistic attempts and find acceptance for strategic changes in the partner organizations, thereby, increasing manageability in the R&D alliances operational work. Therefore, sustainability in the R&D alliance will demand efficient communication and dialogue regarding strategic information, the willingness from strategic decision makers to share information, as well as high demands on individuals to understand and communicate the consequences of this information in the operational work without jeopardizing the company's competitive advantage. However, as with many aspects of less formalized work, an enhanced dialogue regarding strategic information will create great opportunities for individuals to take more responsibility for how their work contributes to the whole of the company's success: leading to company effectiveness and individual growth.

Support Systems for Sustainable Work in R&D Alliances

As aforementioned, employees, such as operational leaders, need a complex set of skills in order for product development companies to be successful through an increased engagement in inter-organizational collaborations. For human resources deployed to be regenerated and work systems to be sustainable in less formalized or post-bureaucratic work, then companies' systems must support the development of such abilities (Docherty *et al.*, 2002a). Related to the design of modern competitive organizations, there is also a growing emphasis on the need for support from "high performance" HR practices (Cressey and Docherty, 2002; Ulrich and Brockbank, 2005). As such, high performance companies – that rely on decentralized decision making and continuous development and learning among highly skilled and committed individuals in order to cope with a rapidly changing environment – demand new approaches to human resource policies. In general, organizations that strive to be competitive through the implementation of less formalized work systems require HR policies that are more integrated in the company's operational context (e.g. training systems that support both formal training and learning in networks and temporary or project organizations, Ulrich, 1997; Docherty, 2002b; Boxall and Purcell, 2008). However, the prerequisites are still little explored for such HR practices to support learning in networks and, therefore, sustainability (Docherty *et al.*, 2002b) (e.g. in relation to innovation, inter-organizational collaborations, or the regeneration of human resources).

The implications of the critical incidents on HRM are discussed in Paper 4. Several areas were related to both the operational and top management levels, where HR functions could bring specific support. The CIT study was not directly designed to investigate HR practices; however, the complete lack of any references to HR functions or HRM activities in the data indicates little awareness of this type of support in relation to R&D alliance work.

A number of implications could be traced to the need for support systems in the organization, with the HR function as a major contributor. First, the findings in Paper 1 show that operational leaders in R&D alliances are expected to fulfill new and demanding roles. As a consequence, these new roles must be defined and accepted in the organization. This also relates to career development regarding which individuals in the organization are the most suitable to fulfill these roles. Furthermore, individual skills and competences must be continuously developed, in terms of both technical competences and informal leadership abilities. Since many of these abilities must be developed from learning in work practice, then both on and off-the-job training programs would be needed (e.g. Boxall and Purcell, 2008). Such activities relate to typical HR competence areas, but are also highly dependent on an understanding of local work practices and cultures, which highlights the specific need for integrated HR practices in order to achieve sustainable work systems.

Secondly, individuals need a comprehensive understanding of one's own processes, routines and corporate cultures, as well as those of the partner, in order to manage collaborative work processes. Implementation of collaborative approaches for example, enhanced dialogue and feedback between different groups in the organization, should therefore be directly promoted by management and supported by HR (Cressey and Docherty, 2002). Moreover, the HR function should also be involved in creating a corporate culture that encourages the individual to take initiatives and engage in the development and change of local processes (Docherty *et al*, 2002b). This was shown to be particularly critical for collaborative work in R&D alliances. Furthermore, as reported in Paper 4, staffing of the R&D alliance project is a task that directly relates to the support from the HR function. Specifically, the results indicate that the staffing of initial meetings is critical and that individuals should also be prepared to have their social abilities (e.g. trustworthiness) and formal skills (e.g. technical competence) tested by a potential partner in these meetings. In addition, the alliance relationship is highly dependent on established inter-personal relationships. The collaborative process could be negatively affected by personnel changes during the alliance; therefore, career development plans, promotions, and resource allocation between different product development projects should be conducted taking the importance of personnel stability in R&D alliance projects into account. Finally, the evaluation of project and process efficiency is frequently suggested as an important issue related to integrated HRM approaches (e.g. Ulrich, 1997; Ulrich and Brockbank, 2005). By adopting a sustainable work systems perspective, R&D alliance performance may be evaluated by measures other than those that are traditionally financial. Measuring internal efficiency by learning, competence development, and external efficiency in terms of innovation ability, flexibility, and competitive strength (Cressey and Docherty, 2002) is more in line with this perspective.

An increased focus on dialogue between different levels of the organization should support the decentralization of strategic information. A specific HRM area, as suggested

in Paper 4, could, therefore, be the development of network and relationships across levels with a specific focus on strategic issues related to the R&D alliance operation.

However, HRM is a broad area; a more comprehensive discussion related to HR practices and support systems for sustainable work in R&D alliances is out of scope of this research. However, the important point is that sustainability in R&D alliance work systems implies numerous specific challenges – for which the HR function should be given the mandate and should be held accountable (e.g. Ulrich, 1997). Hence, a more integrated and practice-oriented collaborative approach between operational leaders and HR representatives should be seen as an opportunity to achieve both high performance and regeneration of human resources in an R&D alliance operation.

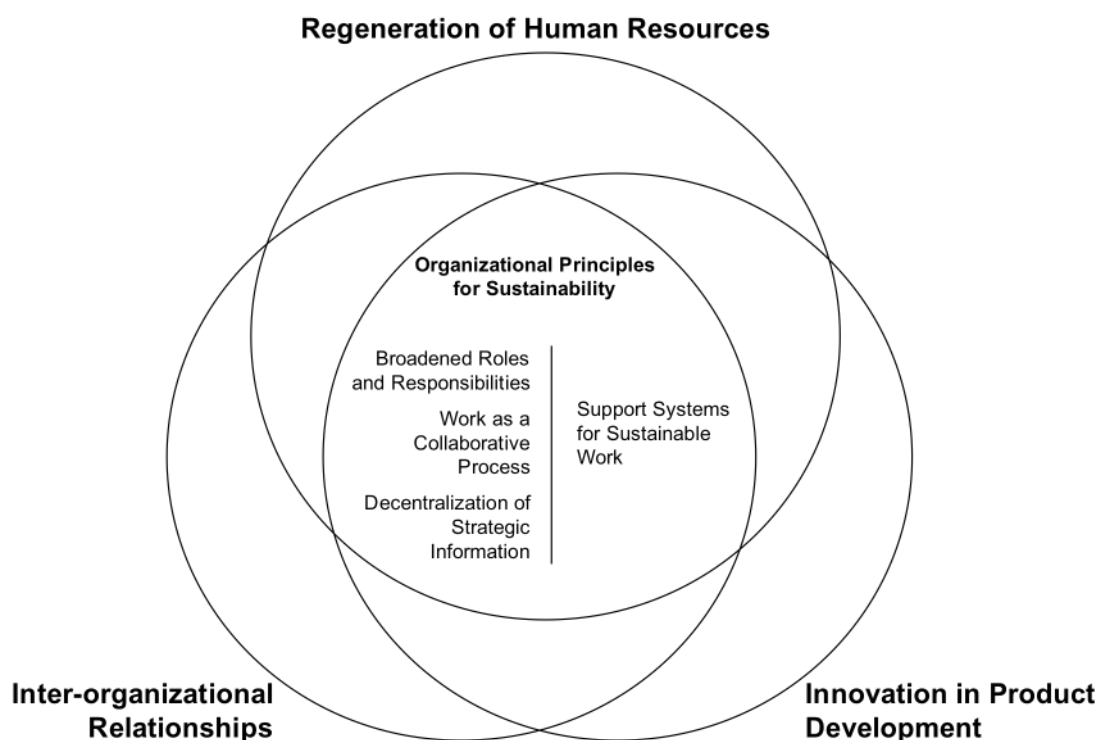


Figure 10. Tentative framework for R&D alliances as sustainable work systems.

In conclusion, Figure 10 intends to illustrate the importance of using organizational principles that simultaneously support multiple goals that are incorporated in a work system in order to achieve sustainability. In the previous discussion, the four organizational principles have specifically related to different risks and opportunities of sustainability in R&D alliances. Therefore, if the four organizational principles are implemented as a means to simultaneously achieve innovation, inter-organizational relationships and the regeneration of human resources, then the framework should be seen as an emerging approach for understanding R&D alliances as sustainable work systems (see Figure 10).

CONCLUSIONS AND FURTHER RESEARCH

R&D alliances represent an important strategic opportunity for product development companies. However, previous research has also acknowledged that these types of inter-organizational relationships represent great managerial challenges as well as significant strategic risks. The aim of this thesis has been to empirically study challenges and opportunities in the operational work in R&D alliances in order to increase the understanding of this type of work system and explore how these work systems could be sustainable.

Theoretical development related to the alliance operations has primarily focused on a dynamic perspective of the alliance process. However, the progress of theoretical development in this area is frequently argued to be hampered by a lack of empirical data on the individual level related to contexts of specific types of alliances. The findings in this thesis have several direct contributions to the understanding of the R&D alliance operation with focus on the individual level.

A central contribution stems from the specific insights given to challenges and opportunities that operational leaders face in the R&D alliance work, in five perspectives on the R&D alliance process: *Formation, Formal R&D process, Informal relationships, Embeddedness, and Exit.*

Furthermore, four critical roles for operational leaders in R&D alliances have been suggested: *Facilitating, Finishing, Ambassadoring, and Trustkeeping.* Leadership roles have not been specifically addressed in previous research on R&D alliances. However, leadership roles represent a major stream in product development literature. Therefore, these findings denote an important contribution and an extension of R&D alliance theory, as well as a first bridge between alliance and product development literature: in terms of requirements on operational leaders.

A framework of trust formation mechanisms has been applied and tested. This concluded that *Process-based, Characteristic-based, and Institutional-based mechanisms* represent important

aspects of how trust is built up or broken down in critical situations. Despite the extensive alliance literature that focuses on trust, what has received significantly less attention is the formation of trust on the operational level – particularly in relation to empirical studies. The relevance of these trust formation mechanisms contributes both to the knowledge of micro-processes of trust formation and specific managerial abilities in R&D alliances.

We have examined the influence of two types of contextual risks that have been addressed in previous alliance research: *relational and performance risks*. The comparative analysis of a sub-sample of four R&D alliances shows that these types of contextual risks influence the operational work in R&D alliances for which operational leaders could be specifically trained and prepared.

Lastly, a tentative framework that addresses support from HRM in inter-organizational context has been developed and analyzed. This has indicated that HRM represents an important, although unexploited, resource for product development organizations when engaging in R&D alliances. Specific contributions regard tasks and participating activities for HRM in order to support both the operation and top management in inter-organizational product development.

The second research question has been how this type of work system can be sustainable. A work systems perspective offers a different view from that of previous research on alliance operations. In contrast to the common focus on the interface between the partners, a work systems perspective emphasizes an integrative view on the operation, and embraces all processes, systems, functions, etc. that are involved in achieving the goals of the alliance.

A tentative framework for the R&D alliance as a sustainable work system has been suggested. The overall findings from this study have been synthesized from a sustainable work systems perspective, based on three organizational principles drawn from practice-centered product innovation: *broadened roles and responsibilities, work as a collaborative process, and decentralization of strategic information*. We have incorporated a fourth principle as well: *support systems for sustainable work*. We have concluded that, in order to be sustainable, companies that engage in R&D alliances should carefully manage and reassess the consequences of these organizational principles in order to simultaneously support the goals that are involved in this type of work system: that is, to simultaneously support *innovation, inter-organizational relationships, and the regeneration of human resources*.

Addressing the concept of sustainable work systems could represent an important and alternative path towards a better understanding of both R&D alliance performance and the suggested high failure rates in these types of inter-organizational relationships. Particularly, the findings in this research describe the risks of human resource consumption and sources of work intensity in an R&D alliance operation. However, they also state the findings concerning opportunities for individuals to grow from experiences of work and the ability to adapt to less formalized work systems. These are examples of unique contributions to alliance literature. Moreover, R&D alliances are directly linked to achieving competitive advantage, the results from this study show that this work implies specific challenges for the regeneration of human resources, which is typical in today's working life. These results are, therefore, also an important contribution to the emerging literature on sustainable work systems.

The methodological approach based on the critical incidents technique proved effective in terms of generating data from the operational level of alliances, covering the actions and the behavior of individuals. Therefore, the demonstrated methodological approach is an additional contribution to the field of alliance research, as well as the emerging field of sustainable work systems.

There are also limitations associated with this study and the applied methodological approach. First of all, the interviews were focused on critical incidents. Therefore, other methodological approaches may uncover further aspects of the R&D alliance operation. Secondly, only one side of the alliances has been studied leaving the possibility that the incident could have been described differently from the view of the other partner. Finally, the retrospective approach of the CIT means that the respondents must recall the alliance operation and the critical incidents from past experiences. However, respondents have identified the incidents as critical, which indicates a good recall.

FURTHER RESEARCH

Several authors have stated that research on the alliance operation is in need of a renewal and that additional methodological approaches could play an important role (e.g. Salk, 2005). This thesis is such an example. However, the inter-organizational context is a complex one, including numerous aspects that influence a specific alliance operation: such as technical and strategic risks. Therefore, further theoretical development would benefit from methodological approaches that enable a firm alignment of established concepts in product development and strategy research in order to validate the results for different types of inter-organizational relationships. One approach could be conducting comparative case studies in combination with critical incident interviews. Such an approach could identify important relationships between product development practices, requirements put on individuals, and the R&D alliance performance in specific settings. Furthermore, a multi-level research approach might also be of particular importance in order to reveal details concerning operational obstacles coming from mismatches between strategic intentions and operational work practices of an individual alliance relationship.

Further research is suggested in order to develop the knowledge regarding leaders as being central actors in the R&D alliance operation. Longitudinal studies that track the work of operational leaders in the alliance context could be used in order to better understand the requirements put on these individuals and how they might change throughout the different stages of the R&D alliance process. In addition, considering the importance of some established roles in product development literature, specific studies focusing on how the inter-organizational context affects, for example, the roles of the gatekeeper and the champion would supplement the findings in this thesis and providing a specific extension to the product development theory.

Furthermore, the product development processes of the partner organizations in this study showed limitations in terms of supporting inter-organizational work. Further studies focusing on differences in managerial approaches adopted in the partner organizations (e.g. the differences in the level of formalization or concurrency in the product development process) could reveal important knowledge about how the way in which a company develops products affects its ability to engage in an R&D alliance.

The implications related to the work system perspective are another aspect that relates to the findings in this study. Alternative research approaches could further assess the challenges related to the R&D alliance embeddedness in partner organizations. One suggestion for further research is to focus on one of the partner's work system and, from this perspective, study how the different parts of a company's organization is affected when the work systems become integrated with those of an R&D alliance partner.

One of the major contributions from this thesis is an increased knowledge regarding the R&D alliance as a sustainable work system. These findings indicate that qualitative studies focusing on the individual's experience from these types of work systems could reveal important knowledge on sustainability in complex working environments. Studies with a direct focus on the individual's experiences of work in different stages, as well as different types of R&D alliances, could further increase our understanding of how this type of work affects the work intensity and the risks of human resource consumption - and, therefore, the alliance performance as well. Furthermore, since inter-organizational collaborations are said to increase both in number and importance for many product-developing companies, studies that enable the comparison of experiences from work in ordinary product development and R&D alliances could be particularly important in enabling a continued understanding of sustainability in product development organizations.

The emerging research on sustainable work systems seeks to continue the tradition of action research and self-design concepts processes. Such research approaches have the potential of contributing to both an increased understanding of context and complexity in knowledge intensive work, as well as the development of human resources and capabilities in the participating organizations. Particularly, the findings in this thesis point to research approaches with a direct involvement of HRM: where organizational principles and support systems could be integrated into the development and training of sustainable work system concepts. However, these approaches pose conflicting interests to product development work since they can impose extra burdens in terms of major time commitments, as well as disclose detailed insight into strategic values of the firm. However, the promises of improved individual abilities related to innovation, inter-organizational relationships, and regeneration of human resources could be a key to competitive advantage of product development companies, therefore, making all of these efforts worthwhile.

APPENDIX 1

Appendix 1. List of Critical Incidents Related to each Themes and Categories of Paper 1

Theme	Category	#CIs	
		Pos	Neg
Formation			
	Partner Criteria	8	3
	Partner Selection	7	2
	Contract Formulation	8	2
	Governance Structure	2	3
	S:A	25	10
Formal R&D Process			
	R&D Process Integration	1	7
	R&D Concept Development	3	3
	R&D Process Pre-Production	2	5
	Knowledge Management	3	4
	S:A	9	19
Informal Relationships			
	Forward Momentum	18	0
	Defensive Actions	0	5
	Politicking	2	8
	Key Personnel	6	1
	Communication Channels	6	1
	Culture	8	8
	S:A	40	23
Embeddedness			
	Own Organization	0	9
	Partner Organization	2	1
	Supply Chain	2	3
	Product Strategy	0	6
	Top Management Involvement	4	0
	S:A	8	19
Exit			
	Exit	2	3
	S:A	2	3

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