

# Critical processes for managing supplier involvement in new product development : an in-depth multiple-case study

**Citation for published version (APA):**

Echtelt, van, F. E. A., Wynstra, J. Y. F., Weele, van, A. J., & Duysters, G. M. (2004). *Critical processes for managing supplier involvement in new product development : an in-depth multiple-case study*. (ECIS working paper series; Vol. 200407). Technische Universiteit Eindhoven.

**Document status and date:**

Published: 01/01/2004

**Document Version:**

Publisher's PDF, also known as Version of Record (includes final page, issue and volume numbers)

**Please check the document version of this publication:**

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
- The final author version and the galley proof are versions of the publication after peer review.
- The final published version features the final layout of the paper including the volume, issue and page numbers.

[Link to publication](#)

**General rights**

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license above, please follow below link for the End User Agreement:

[www.tue.nl/taverne](http://www.tue.nl/taverne)

**Take down policy**

If you believe that this document breaches copyright please contact us at:

[openaccess@tue.nl](mailto:openaccess@tue.nl)

providing details and we will investigate your claim.



**Critical processes for managing supplier involvement  
in new product development:  
an in-depth multiple-case study**

**F.E.A. van Echtelt, J.Y. F. Wynstra, A.J. van Weele, G.M. Duysters**

Eindhoven Centre for Innovation Studies, The Netherlands

Working Paper 04.07

Department of Technology Management

Technische Universiteit Eindhoven, The Netherlands

April 2004

# Critical processes for managing supplier involvement in new product development: an in-depth multiple-case study

Ferrie E.A. van Echtelt<sup>1\*</sup>, J.Y. Finn Wynstra<sup>\*\*</sup>, Arjan J. van Weele<sup>\*</sup>, Geert M. Duysters<sup>\*</sup>

<sup>\*</sup>Eindhoven Centre for Innovation Studies, Eindhoven University of Technology

<sup>\*\*</sup> Erasmus Research Institute for Management, Erasmus University Rotterdam

## Abstract

*Existing studies of supplier involvement in new product development have mainly focused on project-related short-term processes and success-factors. We will test and refine an analytical framework that identifies both long-term strategic processes and short-term, operational processes that are related to supplier involvement. The empirical part of this paper is based on data from a multiple-case study of supplier collaborations within a manufacturer in the copier and printer industry. Our main findings demonstrate that coherent planning and execution of both strategic and operational sets of activities is critical not only in achieving short-term objectives but also long-term benefits of supplier involvement in product development. This study contributes to the Dynamic Capabilities view by providing a more detailed process-based framework that allows us to examine, to explain and to facilitate prescriptions of how companies can effectively build a competitive advantage in product development from resources controlled or possessed by suppliers.*

Key words: new product development; innovation; supplier relations; purchasing.

---

<sup>1</sup> Corresponding author; Arjan van Weele, Eindhoven Centre for Innovation Studies, Eindhoven University of Technology, PO Box 513 - 5600 MB Eindhoven, Netherlands. a.j.v.weele@tm.tue.nl, Tel. +31 40 2473841, Fax +31 40 2465949.



## **The relevance of supplier involvement in product development**

Over the past two decades, several studies have shown that product development has become an increasingly important vehicle in developing or maintaining a strong position in an increasingly competitive business arena (Cooper and Kleinschmidt, 1987; Schoonhoven et al., 1990; Gupta and Wilemon, 1990; Brown and Eisenhardt, 1995; Smith and Reinertsen, 1998). Consequently, the demands on product development performance, in terms of speed, performance and cost, have become more stringent and more difficult to meet. Earlier and more extensive involvement of suppliers in product development is argued to be one of the most efficient ways to enhance product development performance in terms of productivity, speed and product quality (Clark, 1989; Gupta and Souder, 1998; Ragatz, et al. 2002; Primo and Amundson, 2002). Suppliers have been shown to provide a source of innovative ideas and critical technologies (Håkansson, 1987; Bonaccorsi and Lipparini, 1994; Nishiguchi and Ikeda, 1996). At the same time, however, several studies have demonstrated that managing supplier involvement in product development is quite difficult (Birou, 1994; Hartley, 1997a). Companies are constantly subject to pressure to deliver superior value to their customer which requires a set of processes to coordinate, improve and reconfigure of critical external capabilities and resources needed.

Complementary to the majority of existing research, we argue that one of the main factors in achieving successful involvement of suppliers in new product development is related to the coherence between how customers deal with supplier involvement on a (development) project basis, and how they deal with more strategic and long-term processes such as technological roadmapping and the alignment between supplier and manufacturer (Wynstra et al. 2003). Companies are constantly subject to pressure to deliver superior value to their customer which requires the capability to integrate suppliers in short term development projects but at the same time to improve and reconfigure existing and new external and resources critical on the long-term. Most existing research on this topic, however, is restricted to the context of single development projects. This limited conception and the lack of a coherent definition of what managing supplier involvement in product development entails, both in the short- and long-term, form an obstacle to the advancement of knowledge in this field. The

aim of this paper is to increase our current understanding of the specific critical short-term and long-term processes that are needed to effectively manage the involvement of suppliers in product development.

The paper is organized as follows. In Section 2, the concept of supplier involvement is defined and the main contributions and approaches on managing supplier involvement are introduced. In Section 3, the analytical framework and its theoretical premises are discussed. In Section 4, we present the research design, describing the methodology used and the industrial and company context chosen. In Section 5, we present the results of the eight case studies and analyze these using the analytical framework. In Section 6, we interpret the findings and their implications for the management of supplier collaboration in new product development. In Section 7, we conclude by interpreting these results for the more general problem of managing the integration, improvement and reconfiguration of internal and external resources for product development, discussing the limits and potentiality for further extension of this work.

## **2. Previous research on supplier involvement in product development**

Many different definitions of ‘supplier involvement in product development’ have been used in previous studies. In the literature, supplier involvement is, among others, viewed as ‘the integration of capabilities’ (Dowlatshahi, 1998) or ‘as the information suppliers provide and their participation in decision making’ (Handfield, 1999). In our definition, we propose to make a distinction between the supplier’s *contributions*, *tasks* and *responsibilities*, as they reflect the different dimensions that the involvement consists of. Hence, we adopt the following definition:

*‘Supplier involvement’ refers to the resources (capabilities, resources, information, knowledge, ideas) that suppliers provide, the tasks they carry out and the responsibilities they assume regarding the development of a part, process or service for the benefit of a current and/or future buyer’s product development projects.*

## 2.1 Objectives and results

Involving suppliers in product development has been argued to contribute to short-term project performance by improved product quality and a subsequent reduction in development time, and in development- and product costs (Clark, 1989; Birou, 1994; Hartley, 1994; Ragatz, et al., 1997, 2002; Primo and Amundson, 2002). Actual results of supplier involvement are indeed associated with improved quality, enhanced speed and a decrease in development costs as reported by (Imai et al., 1985; Clark, 1989; Wheelwright and Clark, 1992; Nishiguchi, 1994).

Besides these typical project related and short-term benefits of supplier involvement, some authors have pointed at other benefits, which are of a more long-term and/or strategic nature. First of all, a long-term relationship in which experience is built up between two partners can result in a more efficient and effective collaboration in future projects (Dyer and Ouchi 1993; Ragatz, 1997; Sobrero and Roberts, 2002). Parties need to adapt to each other as, over time, they learn more about each other's processes, true requirements and capabilities (Dyer and Ouchi, 1993). Moreover, the supplier may provide better-targeted suggestions that allow for the improvement of the design and performance of a specific part in the future. Supplier involvement may therefore also improve the ability of the manufacturer to differentiate products in the market and to derive a competitive advantage (Rubenstein and Ettlie, 1979; Von Hippel, 1988; Gadde and Snehota, 2000). A second long-term strategic benefit is concerned with the creation of more permanent access to suppliers' (new) technologies, which may be of strategic importance for future product development (Monczka et al., 1998; Bonaccorsi, 1997; Wynstra et al., 2001). A third benefit suggested in the literature is the alignment of technology strategies with key suppliers through aligned technology roadmaps. Handfield et al. (1999) and Monczka et al. (2000) argue that to be able to exploit new market opportunities in the future, companies need to match future product and technological needs with the technological opportunities that become available in supplier markets. Technology roadmaps provide the opportunity to identify broader technological trends, but also enable an efficient discussion about the timing and direction of specific technological progress. Furthermore, the transfer of solutions


developed during the collaboration to other projects can be seen as a fourth long-term benefit (Sobrero and Roberts, 2001).

However, not all results of supplier involvement in product development tend to be positive. Zirger and Hartley (1990) and Hartley et al. (1997b), for instance, found that supplier involvement did not accelerate the actual project cycle time. An explanation for this may be found in the (inherent) risks associated with close collaboration between manufacturer and supplier. Several risks may be at work such as the diffusion of proprietary knowledge, the loss of skills crucial for future product development, the chance of getting locked into a supplier's technology, increasing relationship costs, increasingly incommensurable objectives and diverging levels of commitment between two collaborating partners (Clark and Fujimoto, 1991; Farr and Fisher, 1992; Bruce et al, 1995; Monczka, 1998; Handfield et al., 1999; Gadde and Snehota, 2000; Bensaou, 2000). A more detailed explanation for the mixed results may be found in the contextual characteristics affecting the potential impact of supplier involvement. In some studies, the success of supplier involvement appears to be conditional on market and product contingencies. For example, Eisenhardt and Tabrizi (1995) found that supplier involvement only accelerated product development in *mature* computer industry segments. Apparently, supplier involvement is not an approach that can or should be universally applied.

Also in actually implementing effective supplier involvement, companies are facing serious challenges (Handfield et al., 1999; Evans and Jukes, 2000). Stuart (1997) argues that, '*Although many managers now talk about their desire to turn their suppliers into development partners, the fact of the matter is that actually doing it, after decades of exploiting suppliers by pitting one against the other, is exceedingly difficult.*' Therefore, it can be argued that the way supplier involvement in the product development process is managed can be seen as an important factor in explaining its success (Ragatz et al. 1997; Wynstra et al., 1999; Takeishi, 2001).

## 2.2 Processes

In the existing literature, we find a number of studies that have provided valuable insights in some of the key processes of managing supplier involvement. First, there is a group of studies that argue that

supplier involvement in product development is more effective when close and cooperative buyer-supplier relationships are adopted as opposed to adversarial approaches (Sako, 1993; Mohr and Spekman, 1994; Bruce and Leverick, 1995; Ellram, 1995; Bidault et al., 1998). By studying one-to-one buyer-supplier relationships, these studies provide us with insights into the various different success-factors for effective collaboration. These factors include relationship characteristics such as high levels of trust, management commitment, and certain managerial practices such as information sharing and risk-reward sharing. Within this group, several studies have focused in particular on decisions related to the *extent and moment* of supplier involvement (Clark, 1989; Birou and Fawcett, 1994). The timing of bringing supplier skills and knowledge into the project need to be matched with the relevant stage of the overall product development process; involving too many suppliers at an early stage makes the coordination of development tasks complex and costly. This introduces the notion of designing situationally appropriate relationship coordination mechanisms (Kamath and Liker, 1994; Bensaou and Venkatraman, 1995; Wynstra and Ten Pierick, 2000; Sobrero and Roberts, 2002). The main conclusions from these latter studies is that effective communication behavior during the process of collaboration can only be achieved by matching the coordination mechanisms with the task characteristics, the extent of supplier involvement or the objective of the collaboration at hand. 

A second series of studies have shed more light on the role of the purchasing department in managing supplier involvement and the conditions enabling its effective involvement in product development (Anklesaria and Burt, 1987; Dowlatshahi, 1992; Atuahene-Gima, 1995). These conditions relate to the organizational structure of the purchasing department and the effective integration of buyers in development teams. The skills and behavior of buyers have also been investigated, as has the role of information technology as a facilitator for the exchange and communication of relevant information between the buyer and supplier for product development purposes.

Few studies, however, provide an integrated perspective on managing supplier involvement in terms of activities and decision-making. For that purpose, process-based models may provide a suitable analytical framework and in the following section we present a framework that is largely based



on existing literature (Wynstra et al., 2003). This framework bears some resemblance to the work of Dowlatshahi (1998), Evans and Jukes (2000), Takeishi (2001), but is more comprehensive and makes a more explicit distinction between the strategic, long-term activities on the one hand and the more operational, short-term (project related) activities on the other.

### **3. Conceptual framework**

Wynstra et al. (2003) presents an activity-based framework that identifies roughly 20 managerial activities grouped into four different management areas (Table 1). These activities are shown to contribute to the effective and efficient supplier involvement in product development. In line with our earlier argument that managing supplier involvement entails both short-term and long-term activities, the framework distinguishes four management areas with different time-horizons and management scopes. *Development Management* focuses on establishing the general policies and guidelines for supplier involvement in product development, and the technological areas in which to collaborate. *Supplier Interface Management* focuses on building an infrastructure or network of suppliers that can contribute to product development processes; it concerns the ongoing management of supplier relationships. *Project Management* is primarily concerned with planning and coordinating the involvement of suppliers in specific development projects, and *Product Management* focuses on defining the actual product specifications within a development project (see Table 1). The management activities have been linked to one or more of four basic underlying processes that signal a ‘meaningful’ managerial involvement of the customer. These processes are based on the work of Bonaccorsi (1992) and Håkansson and Eriksson (1993): *prioritizing, mobilizing, coordinating, timing and informing*. ‘Prioritizing’ refers to the choices the manufacturer has to make regarding how and where to invest his resources, not only in terms of selecting actual collaboration partners but also in terms of defining the specific form and intensity of supplier involvement. ‘Mobilizing’ entails encouraging or motivating suppliers to start working on a particular development. Without ‘mobilizing’, suppliers may not be interested and willing to make the necessary commitments and efforts. ‘Coordinating’ involves the adjustment and adaptation of development activities and resources between suppliers and the manufacturer. Without coordination,

joint development will result in ill-fitting components, double work, and incompatible technical solutions. ‘Timing’ refers to a special kind of coordination, which involves the coordination and adaptation of development activities and resources in time. Without timing, product development will suffer from (unexpected) bottlenecks, unnecessary delays, and missed deadlines. Finally, ‘informing’ involves the collection and dissemination of information before or in parallel with the actual involvement of suppliers. In focusing on these basic processes, the emphasis lies mainly on the resources that suppliers may provide in the product development process. This focus has its origins in the *resource dependency theory* (Pfeffer and Salancik, 1979) and the *Industrial Network Approach* (Håkansson, 1987; Axelsson and Easton, 1992) but also in the resource based view (Wernerfelt, 1984; Penrose, 1959).

In this paper, we further contribute to theory on managing interorganizational collaboration with suppliers by focusing more on internal management and organization (Takeishi, 2001) and linking our study to the *resource-based view* and more specific to the *dynamic capabilities view* (Teece and Pisano, 1994). Although the original focus of the resource-based view has been on internal resources (Wernerfelt, 1984; Penrose, 1959), more recent studies have considered alliances as a means to enable a more efficient use of internal as well as external resources. We posit that the dynamic capabilities view can be further detailed and extended by applying it to the context of managing supplier involvement in product development. Teece et al. (1997) define dynamic capabilities as ‘...*the company’s ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments*’. Eisenhardt and Martin (2000) add that they can be ‘...specific organizational and strategic processes (e.g., product innovation, strategic decision making, alliancing) by which managers alter their resource base’. They argue that dynamic capabilities are idiosyncratic in details but share common features ‘...*that are associated with effective processes across firms. There are more and less effective ways to execute particular dynamic capabilities such as alliancing, strategic decision-making, and knowledge brokering. In popular parlance, there is ‘best practice.’* (Eisenhardt and Martin, 2000: 1108). These various “ways” can be described and studied in terms of organizational processes, which have three main roles: coordination/integration (a static concept); learning (a dynamic concept); and reconfiguration (a transformational concept) (Teece,

Pisano and Shuen; 1997). In the context of managing supplier involvement and collaboration with external suppliers we lack sufficient understanding of how these roles can be organized in increasingly rapidly changing environments. For the current study, we have chosen the activity-based framework by Wynstra (2003) as the analytical starting point. The main reason for doing so, is that it provides a *comprehensive* overview of the managerial areas and activities involved by considering both the long-term strategic and the more short-term, operational tasks and their link in achieving short- and long-term objectives of supplier involvement. The four management areas and activities can be regarded as sets of managerial processes that allow companies to coordinate, improve and transform existing configurations of internal and external skills and resources. To that aim, we further examine how these processes are carried out in practice and can be linked to the achievement of short and long-term objectives of supplier involvement. These objectives have been discussed in the previous section. The short-term objectives are related to the quality, cost, and development time and cost objectives that are set for each part. The long-term collaboration objectives are related to future learning benefits, access to supplier's knowledge, alignment of technology roadmaps and transfer of solutions to other projects. We subject the framework to validation in terms of its degree of completeness. Therefore, we develop an in-depth qualitative research design.

Insert Table 1 about here

#### **4. Research design and methodology**

The empirical research is based on a four-year, intensive research collaboration with Océ. Océ is a Dutch manufacturer and provider of a wide range of products and services that enable customers to manage their documents efficiently and effectively by offering innovative print and document management products and services. It has been targeting professional environments such as departmental and central reprographic document processing, electronic data processing (printing salary slips, telephone bills) engineering (printers for CAD and architectural drawings), print shops and publishing environments (books, billboard posters). The company is strongly focusing on innovation,

investing around 6% of its turnover in R&D each year and has been following a niche strategy using unique in-house developed technologies. Océ is strongly dependent on suppliers for the production of parts given the purchasing ratio of more than 70%. This provides a highly relevant context for studying the management of supplier involvement in product development. Although in general, copiers and printer products are in the mature phase of the product life cycle, due to rapid digitization of printers, copiers and communication technologies, product development and service development are becoming increasingly important and knowledge intensive. These characteristics make this company and industry a particularly interesting and dynamic object of study.

This research is designed to enable a longitudinal case study. This allows us to study managerial actions regarding supplier involvement in-depth, in a retrospective as well as on a real-time basis. A *longitudinal case study* provides a single setting with multiple observations over an extended period of time (Yin, 1994; Eisenhardt 1989). Such a research method matches our goal of studying a phenomenon with a dynamic and process nature, and in which the unfolding events play an important role in building explanations (Pettigrew, 1992). Research was carried out at the company's premises for two to three days per week, allowing the researcher to have access to the purchasing, manufacturing and R&D departments. This access enabled many events and discussions to be observed and overheard in a more natural setting, instead of solely relying on pre-arranged interviews. The principal researcher maintained a passive and unobtrusive presence, so as not to interfere with on-going events and activities.

#### 4.1 Case study selection, sample and unit of analysis

We conducted eight case studies that involved collaborations between Océ and a single supplier on the development of a specific part, component or module. These collaborations serve as our main unit of analysis. All of these collaborations – or sub-projects – were part of larger development projects, usually encompassing the development of an entire printer or (copier system). The management activities carried out during (in advance and after) the collaboration between Océ and each supplier has been our primary study object. The case studies were selected in close consultation with managers

from R&D, Manufacturing and Purchasing. Instead of random selection of cases, we used theoretical sampling in our selection approach given the primarily exploratory nature of the research (Yin, 1994). Our aim was to create a representative sample to get a good picture of the company's typical projects and parts. We considered eight case studies as an appropriate number given our desire to examine both retrospective and real-life cases and to examine contrasting cases. More cases would increase the practical and research complexity; a lower number of cases would reduce the richness and variety on selected criteria. Of the eight collaborations in total, three collaborations were part of two development projects that served high-end engineering markets. The remaining five collaborations took place in four development projects that served a variety of high-end office and reproduction service markets. Hence, our cases provided a spread in terms of the market segments served by Océ. The development projects varied in terms of the degree of innovation of the development project in which the cases are embedded (measured by newness of components, configurations and product / manufacturing technologies). This criterion was used because it is considered an important factor that drives the need for specific activities to manage the involvement of suppliers (McDermott and Handfield, 2000; Ragatz, 2002). The collaborations themselves – or rather, the parts involved – varied in terms of technical development complexity. The variation in the degree of technical development complexity was based on the number of different product technologies and the degree to which a part determines the technical specifications and design of other parts (Wynstra and Ten Pierick, 2000). In addition, we deliberately chose to select cases based on different types of technology categories: mechanical parts, mechatronic parts, electronics parts and opto-electronic parts. Although the parts often contain a combination of technologies, they often have a certain core technology. This allowed us to understand whether the management of supplier involvement differs across these technologies. An overview of the characteristics of the selected parts, projects and business units is provided in Table 2.

[Insert Table 2 about here](#)

---

#### 4.2 Data collection

Semi-structured interviews were held for each case study, with representatives from multiple functional areas involved in a specific development project and with managers from several departments in the copier/printer company. In addition, supplier representatives were also consulted to obtain partial verification of case data and to create a better understanding of the problems encountered in the collaboration. Besides numerous informal conversations and observations, in total 183 formal interviews were held, with an average of 19 interviews per case study; the remaining interviews dealt with issues not specific for a particular collaboration. The initial set of interviewees was identified with the help of the steering committee. The need for additional interviews was determined using a 'snowballing' approach. Our largely retrospective cases are subject to the possible risk of interviewees not remembering all of the relevant details (Golden, 1992), oversimplifying and post-hoc attributions, which we have tried to balance by interviewing a substantial amount of people per case. The interviews lasted in general for about 1,5-2 hours.

The basic interview questions were based on the elements of the initial analytical framework, in terms of results, activities and other events. We tried to develop an insight into who had been involved in which aspect of the collaboration. These questions had an open character as to uncover the 'how', the 'who' and the 'when' of the management of collaborations. Since the questions related to the framework might fail to reveal other important events, we asked open questions about the presence of other events and problems in this particular collaboration. For the suppliers, we adapted the Océ questionnaire in terms of how they had experienced the decision-making processes and what they considered to have been the main issues and events. Most of the interviews were recorded, transcribed verbatim and sent back for verification by the interviewee, thereby improving the validity of the case information (Yin, 1994). A logbook that included field notes was also kept as a way to follow different events that occurred in the Océ organization. These notes enriched the case data and were used to verify some of the conclusions drawn in a particular case or to describe the contextual changes affecting that particular case. Information from multiple sources was compared and

interpreted using the analytical framework for managing supplier involvement in product development. We crosschecked which objective historical events and steps have taken place across all interviews, by including other data sources (internal project reports, attendance of different meetings involving members from the R&D and purchasing department). The use of multiple information sources enabled us to validate the information about the same phenomenon by comparing and possibly discussing this information with different representatives (Yin, 1994). Moreover, it provided extra contextual information, which the involved persons might not have recalled independently. For the most extensive case studies (the Optics Unit 1, 3 and MSU cases), events were further verified and discussed in a workshop with relevant managers and project members from R&D, Purchasing and Manufacturing.

Ideally, real-time case studies are used to study processes (Pettigrew 1973; 1992; Pauwels, 2000), but although all collaborations took place between 1989 and 2003, only the two collaborations in the so-called Delta project gave us the opportunity to watch the collaboration unfold in real-time. In order to build the real-time case study periodic updates (approximately every three months) were held with the representatives involved regarding the progress and the events driving the collaboration. To some extent we also followed events after the collaboration with the supplier once the retrospective cases had finished (e.g. optics unit cases and the PC-based controller cases). This was critical to understand possible changes in managing supplier involvement and associated learning effects. Altogether, these various steps allowed us to develop a reasonably reliable and valid identification of causes and effects in the various collaborations.

#### 4.3 Data analysis

Our qualitative analysis started with a historical account of the collaboration in terms of the start of the development activities, followed by the preparation of the collaboration with the selected supplier. The execution of the collaboration was then described and finally the release of the part towards the end of the development project was analyzed. The analytical framework was used to further analyze how Océ has managed the involvement of suppliers before, during and after the development of these

eight parts. We analyze how the patterns in the managerial activities can explain which activities have been critical in contributing to the observed performance of the collaboration in terms of both short- and long-term collaboration results. Therefore, we started by measuring the short and long-term collaboration results of supplier involvement. We then proceeded by distilling the common and unique problems and issues from the case interviews and connect them with the way in which Océ executed the Development Management, Supplier Interface Management, Project Management and Product Management activities. By comparing high- and low-performing cases, we tried to reveal possible dynamic patterns in the order and cycles of various activities. We considered the best performing case to be the one with the highest degree of attainment of short-term collaboration objectives *and* the fewest number of issues and problems.

We now briefly present the eight case studies and build our analysis going through the results, issues, and activity patterns.

## **5. Case analysis and findings**

### 5.1 Case studies

*Optics Unit 1* enables a light projection, specifically the latent image of the original text or image, onto the Organic Photo Conductor using Light Emitting Diodes (LEDs). This part played a crucial role in bringing about the digital transition and had high impact on the final print quality. Océ did neither have a lot of experience yet regarding the digital technology of *Optics Unit 1*, nor a collaboration history with the selected supplier. The collaboration was characterized by gradually reduced supplier design, engineering and assembly responsibility as a result of a mismatch in functional behavior and the technical specifications of the unit and disappointing supplier prototypes. Another important risk to be managed was the assurance of supply continuity, especially during production ramp-up. In the end the overall project was introduced successfully and those optics units that worked were perceived by the customer as offering a significant quality improvement.

Development of *Optics Unit 2* differs essentially from the first collaboration, as it involves an attempt to adapt an existing supplier product and applying it to a more widely used printing process. Since the



overall printer project was driven by time-to-market and cost considerations, the project team chose not to develop a new Optics Unit in-house. The single source supplier from the Asian region, already supplying units for other Océ products, was chosen given the relative cost advantage over the other potential supplier. The collaboration was also characterized by gradually reduced supplier development responsibility, however, during regular production relatively few quality problems appeared. In the third case, a *PC-based Controller* was developed, which controls the data traffic required for several elements of the printer configuration. During the project, a switch was made from a dedicated controller environment to a more standard PC-based controller architecture, for various cost and functionality reasons. The project team had to select twice a PC-supplier, after the first had financial problems. The second supplier was a large PC manufacturer, who indicated that Océ was a European ‘pioneer customer’, in the sense that they were not used to sell PC's that become part of the customer's final end product. The supplier was surprised by the way and extent Océ specified the PC and tried to make changes to standard specifications. During the production start up and the period immediately after, specific logistics and quality problems were reported that disrupted the production process of Océ. Several PC components became obsolete, necessitating continuous testing and validation efforts by the Océ R&D team. On top of that, the supplier introduced a next generation PC before Océ's product was well introduced on the market, yielding functional problems. Similar problems occurred in other projects with this supplier. After market introduction, various inter-organizational teams were formed to address operational, product development and relationship issues.

The fourth case, the *Paper Separation Assembly*, consists of rubber rolls and is critical due to its substantial interaction with the paper and the machine itself. Several functional separation problems occurred during machine tests when using different types of paper relatively late in the engineering phase. R&D tackled this unforeseen problem by investigating and developing largely in-house new rubber compounds for the upper roll, since Océ did not have access to any suppliers who had functional design knowledge regarding ‘separating paper’. As Océ wanted to keep the recipe of the rubber compound secret at that time, it was arranged that Océ would mix the ingredients and supply

the compound to the supplier. The supplier would then produce and assemble the plastic and metal parts. The supplier's input in the engineering process was limited to providing feedback on manufacturability aspects. In the years after the market introduction, many assemblies required a lot of service replacements regarding the rolls and Océ found itself in a captive buyer situation, switching being hardly possible.

*Optics Unit 3* performs a similar function as in the first and second case. The difference was the resolution and the length of the print head, now fitting better with the length of the products the supplier already manufactured. Initially a form of functional, 'black box' development based on the existing supplier prototype was considered feasible. Again, the Océ optics unit development team was surprised by the amount of redesign that it considered necessary. As a result, changing distribution of development tasks and responsibilities during the collaboration. Close to the delayed market introduction, great problems in rejected optics units, and some problems regarding copy quality surfaced. Ultimately, however, the copy quality of the Beta copier was well received in the market.

Case number six, the *Heater Power Supply* (HPS) is an electronics component able to control the power needed for a paper heating function in the Gamma printer. Océ invited several key power supply suppliers to present a solution for a future risk of non-compliance to the European Harmonics and Flickering Norms. This occurred before the actual development of the power supply took place in the Gamma project. One of the suppliers, Cerel, proposed and was chosen to develop a simple but innovative concept that solved the risk of non-compliance to the International Safety Norms.

The *Print Receiving Unit* (PRU) is a part of a larger finishing system. It consists of a tower of four dynamically moving set of trays on which sets of prints are collected and offered to the user. The overall project was one of the first trial projects for increased supplier involvement. For the second supplier, the type of module was new but the paper handling application was familiar. The collaboration was characterized by changing distribution of development tasks and responsibilities between Océ and the supplier, and prolonged discussions regarding cost price and assigning production responsibility. Finally, the *Moving Stapler Unit* (MSU) is a module part of a larger finishing system and staples sheets of paper with high precision and speed, using 2 moving stapler heads. The

overall project was one of the first trial projects for increased supplier involvement, involving a new local supplier. The collaboration was characterized by gradually reduced supplier influence on and contribution to the development, an unstable team composition on both sides, differences in interpretations of technical targets, and prolonged discussions regarding cost and production responsibility.

## 5.2 Collaboration results

The first step in analyzing the cases is to measure the *short-term collaboration results*. Collaboration performance is measured in terms of the degree of attainment of four standard types of development targets (technical performance, material cost, development time and cost), and is based on the objective (written) data regarding targets and actual performance, whenever available. If objective data was not available, judgments from key informants were used. Three different types of informants within the company were asked to provide data on the different performance indicators. These performance measurements were complemented by similar questions regarding the performance of the overall development project to the R&D project leader and verified with project progress reports. The upper part of Table 3 provides an overview of the short-term collaboration results.

Océ succeeded in meeting its own technical performance targets in only half of the collaborations. In just over one-third of the cases, the development time for parts did not undergo any temporary delays. Striking is the pattern we find with respect to material and development costs; Océ appears to meet both targets in only one-quarter of the collaborations. We can also see that no collaboration performed much better than the initial targets, the exception being the part cost performance of the paper separation assembly.

Insert Table 3 about here

In addition to measuring the degree to which the specific development targets are met, we measure a number of long-term benefits<sup>4</sup> (see bottom part of Table 3). First, a more efficient and effective future collaboration<sup>7</sup> is expected to occur in several collaborations as a result of the learning experiences of the people involved. Overall, this long-term benefit appears to be mentioned most frequently by the Océ representatives involved. Based on the problems and discussions encountered in this collaboration, both buyers and engineers feel they will be able to work together on part design faster and more effectively next time. Only in those collaborations with low supplier involvement, no such learning experiences were observed. In the heater power supply case, the additional learning experience was not considered to be high because of the extensive previous experience and the degree of knowledge about each other's needs and capabilities. Although the first two optics unit cases took place in parallel for several years, the learning experiences concerning technical and organizational issues encountered with Optico were only shared informally and not very intensively within Océ. In a second project with Sorto, this supplier was asked to co-develop a similar PRU but none of the long-term learning benefits were captured due to the premature termination of the collaboration. This raises the question of whether and to what extent Océ effectively transferred learning experiences from the various collaborations. In some collaborations, improved *access to supplier's technology and knowledge* was recorded, but was limited. In the case of Optico, the two initial projects increased the access to the supplier's technology, and in particular to its Optics design and production technology. However, Océ had to develop most of the functional and design-related knowledge internally. Therefore, Océ did not improve its access to other capabilities as much as it would have liked. In the PRU case, the access was not improved as much, as it depended on the experience of the supplier's senior engineer and the divestment of internal plastic molding production. The *alignment of technology roadmaps* was particularly important in the optics unit cases and the PC-based controller cases, whereas such a benefit was not considered to be important in the paper separation assembly case. The collaborations regarding Optics Unit 1 and 3 did not immediately result in an aligned roadmap.

---

<sup>4</sup> We asked the engineers and buyers involved to what extent they perceived the collaboration had achieved, or was expected to result, in a number of long-term benefits. Due to the qualitative nature of these benefits and the lack of follow-up collaborations in a number of cases, 'expected' results were the only possible frame of reference.

However, in the years following, the actual production numbers (i.e. sales for the supplier) slowly increased the motivation to share somewhat more information with R&D. The dialogue on future technological needs and Optico's investment planning grew more intensively in the years that followed. In the PC-based controller case, it took several years of collaboration before the exchange of information regarding future planning improved. In line with previous literature (Monczka et al., 2000) these observations suggest that it takes a considerable time to achieve roadmap alignment, because it is likely to require information sharing, which presupposes a willingness to share and also an appropriate channel by which to share and discuss. We did not find many instances of the *transfer of solutions and concepts* from one collaboration to the other. Although the collaboration in the power supply case resulted in a solution that could be used in other projects, this has not yet occurred. The Moon project functioned as a starting point for a PC-based controller platform policy in other projects.

To summarize, a distinctive pattern of time and resource-consuming collaborations can be observed in which Océ encountered more technical problems than anticipated. One can also observe the presence of (potential) long-term collaboration benefits that could partly compensate, or at least alleviate, the negative short-term results.

### 5.3 Issues and problems

We proceed to distill the most significant common and unique issues and problems encountered during the collaboration as they can reveal symptoms of particular problematic managerial activities. Table 4 presents a list of these issues and problems, which have been distilled from the case interviews. One of the top ranking issues is the occurrence of unexpected technical problems during development. These problems were related to a mixture of quality aspects such as functional performance, durability and non-conformance of delivered parts to the specifications. Secondly, in more than half of the cases, discussions took place regarding the feasibility of assembly and design responsibilities assigned to the suppliers. During the process doubts arose regarding the initial supplier choice. In some of these cases, these doubts resulted in a reduction in the extent of design outsourcing and in the level of assembly outsourcing. Sometimes, Océ decided, or was forced, to change suppliers

during the project. In five cases, the part cost targets and development cost budgets required lengthy discussions late in the project. Océ was also confronted with high risks regarding part availability and obsolete components. Short component life cycles endangered the achievement of production targets but also necessitated an increased effort in validating the new components in the Océ-specific machine environment. The sharing of technology roadmaps and the access to critical design info were particularly important (but somewhat unique) issues in the PC-based controller case. These issues raise questions as to how Océ selects its suppliers and plans their involvement in different projects. Furthermore, what does Océ do to create internal commitment and foster long-term relationships when it sets out a strategy for increasing supplier involvement? How does it detect and mitigate the risks associated with developing parts with suppliers? Our analysis of the managerial activities in the four areas in the next section should reveal which processes are critical to capture the short and long-term benefits from supplier involvement.

Insert Table 4 about here

#### 5.4 Management activities

We further examine the issues identified above in terms of their connection with the various managerial activities in the four areas: the two short-term management areas of Product Management and Project Management, and the two long-term, strategic management areas of Development Management and Supplier Interface Management. We start by analyzing the short-term activities after which we extend the analysis to analyzing the characteristics of the activities in the DM and SIM areas. This specific order allows us to determine the strategic and operational support provided to integrating the suppliers in development projects and allows us to understand how the activities have contributed to achieving the long-term benefits in the collaborations. In other words, it allows us to provide a better explanation of the results and relationships between the roles of integration, learning and reconfiguration performed by the sets of managerial activities. Subsequent tables provide an

overview of these activities, where the first column contains the issues that have also been put in the case boxes in which they occurred. The findings are summarized in Table 5.

Insert Table 5 about here

We can observe that the *Project Management* activities were executed in significantly different ways in the high-performing heater power supply case and the majority of the other cases.

Two peculiar patterns emerge in the project management area. On the one hand, the first collaboration is characterized by fast decision-making associated with the four planning activities. These decisions largely ensured a smooth collaboration with Cerel in the Gamma project. The clear demarcation of the power supply as a technology/function area and the presence of potential competent suppliers were particularly helpful. All departments agreed to the final supplier choice and its expected contribution was not subject to much discussion. The discussion focused on solving a potential norm problem. The two different moments of involvement were also well timed and allowed the overall project to perform the machine tests with the prototypes delivered on time. The development activities with Cerel were coordinated efficiently, using a simple and effective communication interface. Although technical issues had to be addressed, they did not differ from the usual iterations that are necessary to realize a power supply. On the other hand, the remaining cases demonstrate a different pattern. Only a small amount of time and effort was spent on defining which parts were candidate for outsourcing and on finding and choosing an appropriate supplier. This was quickly followed by the actual technical collaboration with the supplier. In the majority of cases a variety of technical and organizational problems soon emerged during the collaboration, resulting in increased co-ordination between Océ and the first and second tier suppliers. During the evaluation of product designs (prototypes), in particular, the development teams experienced a disappointing intermediate quality level of design and engineering. In all these cases, both the co-ordination effort from R&D, Manufacturing and Purchasing and doubts about the supplier's true technical design engineering or manufacturing-related (e.g. assembly, fine-tuning, testing) capabilities increased. These

doubts subsequently fostered the perceived need to increase Océ's internal control of development, and later on of assembly activities. In most of the cases a pattern emerged varying from prolonged discussions regarding supplier choices or possibly transferring outsourced development and assembly-related tasks back to Océ, to actually reversing these earlier decisions. The paper separation assembly case is characterized by a very limited role of the supplier during development, and we therefore do not observe this pattern of reversing earlier decisions. Although co-ordination problems did exist, they occurred during the regular production phase.

Océ appears to carry out its *Product Management* activities in a well-organized fashion. However, it is not always able meet technical performance and cost price objectives, let alone in an efficient way.

Insert Table 6 about here

Although Océ can come up with information on new and alternative products, technologies and suppliers, the information is not always immediately available and requires in-project search effort. The evaluation of the design appears to be a core project execution activity, which points to a significant number of risks that need to be addressed. The analysis suggests that these risks were not anticipated and consequently forced Océ to put more internal effort into the development of the parts than expected. Finally, instead of sticking to off-the-shelf parts, Océ appears to prefer customer-specific designs/specifications, either selecting them from the start or moving towards them during the collaboration. The lack of a continued focus on simplification and standardization has therefore partially contributed to a slipping cost price and increased the co-ordination costs during and after the projects.

In the area of *Development Management*, we now analyze how, and the extent to which, Océ provided long-term strategic and operational guidance to development projects, facilitating the typical decisions and activities regarding the management of supplier involvement (see Table 7). Océ has been attempting to develop a simple *policy regarding the 'in- outsourcing' of technologies* (DM1). In the period



during which the optics unit case studies started up, a brief core message regarding in-outsourcing emerged stating, ‘*Océ buys, unless...*’. This statement underlines the company’s general outsourcing trend over the past 20 years across all business units. Océ decided to keep the development of its own color technology and production activities of key components in-house because of their strategic importance. This policy was well known in all departments. However, when the Star and Beta projects started, a less detailed policy with regard to outsourcing was available for the technologies enabling the digital transition (Optics Units cases). It is fair to state that the policy regarding the in- or outsourcing of development, engineering, production and assembly activities of the optics units was largely left to the discretion of the individual development project team. A number of initiatives by several departments did aim to influence the extent of outsourcing in product development and assembly activities for products developed for both business units. While the engineering of parts of final copiers and printers traditionally was an in-house R&D activity, the electronics engineering group formulated and implemented a policy for increased outsourcing of development and engineering tasks for parts such as power supplies. The policy was well known among the people involved and reduced the number of develop-or-buy options to consider, thereby speeding up decision-making in the power supply case. The outsourcing of the paper handling modules in the PRU and MSU cases were set-up in the light of policy initiatives from various departments to increase the level of outsourcing of engineering and assembly tasks to suppliers. However, given the fact that some of the outsourced tasks were insourced again we can conclude that the policy was implemented with mixed success. If we look at *Océ’s degree of active formulation and communication of guidelines for supplier involvement and for IPDS-related activities of internal departments* (DM 2-4), we observe that they appear to be insufficiently available and communicated – with new suppliers in particular (Brinkman, 2003). In the PRU, MSU and PC-based controller cases, suppliers themselves indicate that Océ’s organization and its procedures were not very transparent. This indicates that insufficient acknowledgement and attention was paid to the learning and adaptation time needed by the supplier and by Océ itself. We found that guidelines for internal decision-making are more advanced than those for collaborations with suppliers. For example, a description of the supplier selection procedure was present (in the purchasing department) and a

portfolio instrument was used in project teams to identify and assess risks of buy parts. However, we found a deviation from this routine in the actual pattern of decision-making for new and more complex parts. Supplier selection and determining the extent of supplier involvement were not based on a transparent routine. Such guidelines were apparently lacking or simply ignored.

Insert Table 7 about here

Examining the pattern of *Supplier Interface Management* activities in Table 8 reveals that Océ did not proactively and persistently engage in the various activities to build up a capable supplier base. As such we encounter varying support from these activities in the Project Management and Product Management areas. In particular, the provision of information and suggestions of alternative suppliers and technologies and the supplier selection activities have required significant in-project effort with the positive exception of the power supply case. The more permanent scanning of supplier markets occurs ad-hoc from time to time. The case studies also suggest that motivating suppliers is considered to be important but only partially successful. The activity is not carried out in a structured and coordinated way. Although attempts were made to use existing supplier products and capabilities, project teams had to resort to (non-intended) customized solutions in several collaborations (PC-based controller, Optics Units 1,2,3). Therefore, the extent of monitoring of technological developments, pre-selecting suppliers and leveraging existing supplier capabilities have not allowed a faster decision-making and effective execution of the collaboration. Evaluation of supplier performance tended to be one-off initiatives, despite some attempts in the cases examined. The information experiences do not appear to be stored, transferred or followed-up in a structured fashion. Therefore, the evaluation of supplier performance in product development has not fostered learning and improvement of collaboration for following collaboration periods, partially because it is not embedded in the (formalized) routines of the organization.

Insert Table 8 about here

## 6. Discussion

### 6.1 Interpreting the case findings

The heater power supply case achieved the best overall results in terms of meeting the short-term technical performance, the development time and development cost targets. This was closely followed by the PRU case and the Optics Unit 2 case. However, analysing the long-term benefits, we observed that learning experiences also arose in cases in which the short-term collaboration results were below target. Some collaborations were therefore more valuable than they were initially considered to be.

Using our analytical framework, we reveal that the origins of problematic collaborations can be largely attributed to a number of internal decisions related to the set-up and management of collaborations within a project and the formulation and implementation of strategic direction. The success in the heater power supply case can be partially traced back to the combination of *well-executed Project and Product Management activities*. In most of the other cases, Océ has been insufficiently able to anticipate and efficiently address the technical and organizational risks associated with particular supplier choices and workloads outsourced. The critical management activities that underlie the problems were related to the way it defined the desired collaboration area by decomposing the final product into appropriate buy parts and it selected suppliers. The heater power supply case differed considerably in terms of the high degree and timely moment of cross-functional involvement of key actors from R&D, Purchasing and Manufacturing in specific decision-making processes. In most other cases, the selection of suppliers and the determination of the development ‘workload’ of suppliers was done in a way that management and project team members did not always systematically agree on and neither internally nor externally were all relevant criteria identified in advance. The results were (temporary) misalignments in the expected and actual capabilities and extra coordination and ‘repair’ costs. Moreover, weak commitment for supplier choices and ongoing discussions and doubts occurred during and after the project.

Additional explanations for the difficulties in achieving effective and efficient supplier involvement at Océ can be found in the extent and way in which the firm managed supplier involvement through

execution of *Development* and *Supplier Interface Management* activities. Improving and reconfiguring the supplier base, to achieve a higher added value of the supplier in product development and assembly, was a process full of obstacles and involved a great deal of trial and error. First of all, Océ did not have a clear, consistent and comprehensive approach to pre-qualifying suppliers for involvement in product development. In particular, its pre-selection approach and supplier base during the period of the case studies did not support its intention to increase the involvement of suppliers in development and assembly for several new multi-technology parts. The only exception was found in the heater power supply case. Moreover, Océ did not have clear supplier involvement guidelines for setting up and managing new collaborations. This resulted in extra effort and misunderstandings, and thus prolonged the adaptation time of the Océ and supplier's organizations. Océ appeared to be a particularly project-driven organization with respect to product development. Furthermore, the collaboration with suppliers was particularly hindered by the existence of a diverse set of terms in the various departments, with implicit assumptions and expectations about the role of suppliers in product development. Finally, Océ did not create the conditions to benefit from existing supplier products and designs in time. In other words, Océ resorted to adaptations to supplier-generated specifications or designs. This undermined the speed and resource advantages that should be realized in developing the part, but also in logistics management, manufacturing and service for these parts.

## 6.2 Reflections on the analytical framework

The findings in the Océ cases demonstrate that the initial planning activities in the *Project Management* area are critical in successfully anticipating and dealing with possible risks, and can prevent unexpected higher development costs and time. The process of selecting the supplier and determining their extent of involvement are critical in anticipating and addressing the technical and organizational risks associated with particular choices about suppliers and workload outsourcing.

*Product management* activities are crucial in making the right trade-offs and integrating (standard) supplier technologies in a specific project. They visibly affect the achievement of technical performance targets and the control over the cost price. Timely consideration of alternative solutions

and an integrated evaluation of product design, involving the relevant representatives early on in the project, were important in all of the case studies. Product management activities can also result in higher development costs and time. An incorrect evaluation of a design with respect to issues such as costs, quality, part availability etc., increases the search for alternative suppliers and increases co-ordination costs. Failing to create the conditions for implementing the intended standardization of parts, or designing complex parts, increases the costs of co-ordination during development and increases the field service costs afterwards.

Our analysis of the critical *Development Management* and *Supplier Interface Management* activities reveals that a coherent and combined policy guideline and supplier base development was most effective for a specific technology category (i.e. the power supply category). The effort invested in developing a clear in-outsourcing policy for technology and product development activities, and in pre-selecting and motivating suppliers, gave the buyer and engineer a head start in involving the right supplier quickly and effectively. Therefore, Development Management and Supplier Interface Management, implemented as permanent activities, can indeed contribute to improved collaboration results. Looking at the influence of the managerial activities on capturing the long-term collaboration benefits, we found that active execution of Develop Management helps to achieve these benefits in two ways. First, it provides a long-term view on the desired internal and external capabilities that need to be built up, allowing a particular specialization to be developed. It takes away extensive in-project discussions regarding which develop-or-buy solutions to choose. This subsequently allows the customer and supplier to gain experience in the context of a clear division of tasks. Secondly, it directs attention towards the type of efforts needed in the Supplier Interface Management area in order to align technology roadmaps. This benefit may only be significant for specific collaborations concerning technologies/parts with a high strategic impact (critical product differentiator or high cost impact). We also contend that Supplier Interface Management activities allow potential learning experiences to be transferred to future collaboration episodes, thus contributing to a better match in the capabilities of the customer and supplier. Although Océ did indicate that it has learnt from its experiences in several cases, and other long-term results have been partially achieved, the benefits did not seem to be

captured automatically. Pressures to achieve short-term success and the failure to make them visible create an atmosphere in which the value of longer-term benefits is hardly considered. Follow-up collaborations may be affected by negative experiences in the current collaboration. Suppliers sense an internally divided view and a strong project driven culture, which affects their willingness to collaborate, and also their trust. The absence of a clear long-term relationship management structure for key suppliers to effectively set out the long-term path of collaboration and learn from current experiences hinders effective transfer to follow-up collaborations.

In this sense we have revealed the clear difficulties associated with the process of altering the resource base. Improving existing resource configurations close to the status quo is relatively easy. However, increased supplier involvement requires unlearning and adjustment in behavior in order to be able to integrate and reap the rents from new resource configurations. Short-term project driven management, a non-coherent vision on what to outsource and a lacking framework for defining the supplier's contributions to strive for and the subsequent limited preparation are ingredients for recurrent operational problems. We may conclude that the causes for these problems are more internally oriented rather than only located in specific characteristics of the relationship with the supplier.

### 6.3 Adaptations to the framework

Based on the case studies, we propose a number of adaptations to the original conceptual framework; the first focuses on the distinction of different management areas, and the other is related to the individual management activities within these areas.

Applying the framework to the case studies at Océ demonstrates that Development (DM) and Supplier Interface Management (SIM) activities, on the one hand, and the Project Management (PJM) and Product Management (PDM) activities on the other hand, take place in two entirely different management 'arenas': the first two in a more strategic, long-term oriented setting and the latter two in a more operational, project-related short-term setting. Although the case studies clearly demonstrate the links between these two management arenas and the detrimental impact of just performing

managerial activities in one of these two arenas, it has become quite apparent that Océ has not yet fully achieved the desirable coherence between the two. These findings also demonstrate that it may not be fully necessary or appropriate to distinguish between *four* management areas. In terms of the extent and the way they are carried out, the activities in the Development Management and Supplier Interface Management areas were found to be much stronger related than previously argued (Wynstra et al., 1999; 2003). We argue that by merging the two areas, the model better reflects the strong connection between the policy and guideline development and the creation of access to supplier resources and capabilities relevant for current and future projects. Development and Supplier Interface Management can be viewed as one shared ‘Strategic Management’ arena because of their similar long-term orientation and support functions in the management of supplier involvement in projects. The activities in both areas ensure that a learning and partially a transforming role can be fulfilled. The activities result in improved use of existing and in new configurations of internal and external resources, which better match with changing market conditions and technologies.

As for the other areas, originally the framework distinguished between Project and Product Management because the former contained activities with an organization and process character, while the latter encompassed activities that directly contributed to the improvement of the part design. The case studies suggest that they share a short-term and project-specific horizon. The project is the vehicle and context in which various tasks are carried out and decisions are made affecting and related to the involvement of different suppliers. Content and process often go hand in hand and follow in practice to some extent a sequence because of interdependence between project and product management activities and also with the overall product development phasing. Hence, we propose to combine these two areas into one management arena i.e. ‘Operational Management’.

As for the individual management activities, a number of the descriptions in the original analytical framework regard tightly related activities, such as formulating external, respectively internal, policies for supplier involvement. Our first adaptation is to combine a few activities, and to consider such a composite activity category as a *managerial process*. We consider the managerial processes as basic categories of strategic and operational tasks decided on before, during or at the end of a development

project. The proposed adaptation enables us to better study the relevant decisions and behavior related to managing supplier involvement. It simplifies the framework by reducing the number of activities, and at the same time provides more detail about the underlying activities. Figure 1 illustrates the proposed redefinition of the management areas.

The Strategic Management arena now contains seven processes in contrast to the nine activities in the original Development Management and Supplier Interface Management areas. These seven processes are considered in a cycle, which reflects the planning, executional and evaluative stages in developing policies and the desired supplier base. Although the processes are, in reality, considered to be executed in an iterative and interactive conjoint way, the sequence in the Strategic Management Processes serves as a reference for understanding their interrelations (see Figure 1). Whereas the aforementioned strategic management processes share their long-term and support focus before and across different projects, the Operational Management processes are the engine to effectively set up and manage different collaborations within a development project. We propose nine redefined managerial processes as opposed to the twelve activities grouped in the former Project and Product management areas. Moreover, we introduce a certain order in the processes, because we observed that activities within the Product Management area actually occur in conjunction with the activities in the specific planning and execution areas of Project Management. The result is an operational management cycle of processes that reflects the planning, executional and evaluative stages in development projects. Again, this representation is based upon empirical observations that do not exclude the possibility of deviations in terms of the moments at which some of the processes start or in terms of their duration.

Insert Figure 1 about here

## **7 Conclusions and implications**

This study has addressed the question what effective management of supplier involvement consists and examined a number of processes in terms of decision-making and tasks in different management



areas. The analysis of supplier involvement cases revealed that the high and low performing collaborations and the associated issues and problems could largely be explained by the persistent patterns in the extent to which Océ planned and set-up supplier involvement. We found that our initial framework was helpful in understanding why certain collaborations were not effectively managed, yet concluded that the analytical distinction of four management areas did not sufficiently reflect empirical reality. This led us to reconceptualize and further detail the framework. Instead of four managerial areas, we propose to distinguish between the *Strategic Management* arena and the *Operational Management* arena. The Strategic Management arena contains seven processes that together provide long-term, strategic direction and operational support for project teams adopting supplier involvement. These processes also contribute to building up a *willing* and *capable* supplier base to meet the current and changing future technology and capability needs. The Operational Management arena contains nine processes that are aimed at planning, managing and evaluating the actual collaborations in terms of their intermediate and final development performance in a development project.

The success of involving suppliers in product development as a strategy depends on the firm's ability to capture both short-term and long-term benefits. If companies spend most of their time on operational management in development projects, they will fail to use the 'leverage' effect of planning and preparing such involvement through strategic management activities. Also, they will not be sufficiently positioned to capture possible long-term technology and learning benefits that may spin off from individual projects. Long-term collaboration benefits can only be captured if a company can build long-term relationships with key suppliers, where it builds learning routines and ensures that the capability sets of both parties are still aligned and are still useful for new joint projects. To obtain such benefits, companies need a set of strategic decision-making processes that help to create this alignment. Having established explicit and extensive strategies, a company obviously still needs a set of operational management processes to identify the right partners and the appropriate level of supplier involvement for the various suppliers in a specific project, using the support from the strategic directions and guidelines. The two arenas are both distinct and interrelated, as the interplay between short-term project interests and long-term strategic interests are managed in these arenas.

In this paper, we have presented a coherent conceptual framework of activities and short and long-term objectives of supplier involvement results and linked this framework to the three roles of managerial processes in the Dynamic Capabilities view (Teece and Pisano, 1994; Teece et al., 1997, Eisenhardt and Martin, 2000). The processes presented in the analytical framework, when properly executed, together form an important element of a company capability to integrate external suppliers' resources (e.g. know-how, technologies, supplier networks, investments) in product development projects. Furthermore they enable a company to actually improve and adapt the existing resource base in the long-term through different episodes of collaboration in the context of development projects. Our contribution to knowledge in the area of interorganizational collaboration with suppliers in product development regards a detailed and coherent analytical framework that allows to examine, to explain and to facilitate prescription how companies can effectively build/derive competitive advantage from resources controlled or possessed by suppliers.

#### 7.1 Limitations and recommendations for future research

To conclude, we acknowledge the current study entails a number of limitations. First, we have not analyzed nor provided prescriptions about who, i.e. which department, should take what role in executing the various processes. Based on the case studies presented here, and previous research, we argue that the question 'who should be involved in which activity' is relevant only after the critical processes and tasks are known. We suggest that the skills of, and the interaction between, key representatives in the functional and project organization in companies' outsourcing processes need to be further examined.

Secondly, we have not discussed the preconditions that are necessary in order to be able to fulfill the different processes. Although we did not focus on *enablers* in this paper, such conditions could be analyzed at least at three different relevant levels in the organization. At the level of the business unit an organization should be present that is conducive to cross-functional collaboration, exchange of information internally and to coordination with suppliers externally during different phases. Next, at the level of the project team, enablers then ensure that the business unit enablers are

in fact available and are supporting a specific project with different collaborations. The collaboration enablers form the conditions for effective supplier involvement that are most directly related to a single collaboration. Adequate supplier capabilities in line with the desired role, available collaboration experience, degree of mutual trust, and cultural compatibility and operating style are factors that can largely facilitate the collaboration in development projects. Assessing, monitoring and intervening in these conditions can help in anticipating and addressing the barriers and risks in a more effective way.

Finally, one can argue that an explicit *contingency view* on managing supplier involvement is required, given the differences in the internal and external environment of both the customer's or business unit organization and the specific project and parts/collaborations within a project. Contingency theory posits that different organizational solutions can be effective to deal with uncertainty or complexity (Burns and Stalker, 1961; Lawrence and Lorsch, 1967; Van de Ven, 1985). Analysis of contingency or *driving* factors at business unit, project and collaboration level could help us further to determine whether specific processes need to be more actively executed to effectively deal with sources of complexity, risk or uncertainty. For example, large organizations generally need more guidelines to organize and coordinate the work between various departments and suppliers (Wynstra et al., 2000). High technological uncertainty may require more intensive monitoring of technological developments and active leveraging of supplier's existing capabilities (e.g. standard available products). At the project level, we can argue that complex and innovative products require highly active execution of most of the operational management processes. High degrees of product innovation may increase the need for activities and mechanisms that bring in relevant information on technologies early on in the development process (McDermott and Handfield, 2000). Sources of risk, uncertainty and complexity associated with a specific collaboration (e.g. technical complexity of the part) trigger the need for particular choices in terms of the communication interface and the type of co-ordination mechanisms to be used during development (Sobrero and Roberts, 2001).

In terms of relevant and valuable future research, one avenue would be the further application and validation of the framework in different company and industry contexts and comparing the practices and pre-conditions of supplier involvement. Furthermore, research efforts may be directed

towards the investigation of appropriate informal and formal mechanisms that enable effective learning across different departments and with suppliers in the context of higher supplier involvement in product development. Informal socializing mechanisms and co-location of supplier engineers (guest engineering) in the project team are frequently mentioned as means to improve supplier involvement success (Lamming, 1993; Monczka et al., 2000; Lewis Slack and Twigg, 2001). The question remains, however, whether these mechanisms are also effective in improving *processes* across departments and suppliers. Secondly, the role of target setting and reward systems in supporting or undermining supplier involvement in product development could be examined. Reward systems can heavily influence the disposition, commitment and behavior of people towards increased supplier involvement. Applying previous research on the effect of rewards systems in the specific area of supplier involvement can generate important insights in how to create an organization that is prepared and willing to closely explore and act upon the opportunities of supplier involvement.

## References

- Anklesaria, J., Burt, D.N., 1987. Personal factors in the purchasing/engineering interface. *Journal of Purchasing and Materials Management*. 23 (1), 190–202.
- Atuahene-Gima, K. 1995. Involving organisational buyers in new product development. *Industrial Marketing Management*. 24 (3), 215–226.
- Axelsson, B., Easton, G., 1992. *Industrial networks: a new view of reality*. London: Routledge.
- Bensaou, M., 1999. Portfolios of Buyer-Supplier Relationships. *Sloan Management Review*. 40, 35-44.
- Bensaou, M. and N. Venkatraman 1995. Configurations of interorganizational relationships: A comparison between U.S. and Japanese automakers', *Management Science*, 41 (9), 1471-1492.
- Bidault, F., Despres, C., Butler C., 1998. The drivers of cooperation between buyers and suppliers for product innovation. *Research Policy*. 26 (7/8), 719–732.
- Birou, L.M., Fawcett S.E., 1994. Supplier involvement in integrated product development: a comparison of US and European practices. *International Journal of Physical Distribution and Logistics Management*. 24 (5), 4–14.
- Birou, L.M., 1994. *The role of the buyer-supplier linkage in an integrated product development environment'*, doctoral thesis, Michigan State University.
- Bonaccorsi, A., 1992. A Framework for Integrating Technology and Procurement Strategy”, *Conference Proceedings of the 8th IMP Conference, Lyon*, pp. 33-41.
- Bonaccorsi, A., Lipparini, A., 1994. Strategic partnerships in new product development: an Italian case study. *Journal of Product Innovation Management*. 11 (1), 134-145.
- Bonaccorsi, A., 1997. The External and Internal Integration of Resources: Evidence from a survey on procurement practices of medium and large manufacturing firms. *Conference Proceedings of the 6th IPSERA Annual Conference, Ischia, 24-26 March*, pp. 1-20.
- Brown, S.L., Eisenhardt, K.M., 1995. Product development: Past research, present findings, and future. *The Academy of Management Review*. 20 (2), 343-379.
- Bruce, M., Leverick, F. Littler, D., Wilson, D., 1995. Success Factors for Collaborative Product Development: a Study of Suppliers of Information and Communication Technology. *R&D Management*. 25, 33-44.
- Burns, T., Stalker, G.M., 1961. *The Management of Innovation*. London: Tavistock.
- Clark, K.B., 1989. Project Scope and project performance: the effects of parts strategy and supplier involvement on product development. *Management Science*. 35 (10), 1247-1263.
- Clark, K.B., Fujimoto, T. 1991. *Product Development Performance: Strategy, Organization and Management in the World Auto Industry*. Harvard Business School Press, Boston.
- Cooper, R.J., Kleinschmidt, E.J., 1987. An Investigation in the New Product Process: Steps, Deficiencies and Impact. *Journal of Product Innovation Management*. 3, 71-85.
- Daft, R.L., Lengel, R.H. 1986. Organizational information requirements, media richness, and structural

- design. *Management Science*. 32 (5), 554-571.
- Dowlatshahi, S., 1998. Implementing early supplier involvement: a conceptual framework. *International Journal of Operations and Production Management*. 18 (2), 143-167.
- Dyer J.H., Ouchi, W.G., 1993. Japanese-style partnerships: giving companies a competitive edge. *Sloan Management Review*, (Fall) 51–63.
- Eisenhardt, K. M. 1989. Building Theories from case study research. *Academy of Management Review*, 14, 488-511.
- Eisenhardt, K.M., Tabrizi, B.N. 1995. Accelerating adaptive processes: Product innovation in the global computer industry. *Administrative Science Quarterly*. 40, 84-110.
- Eisenhardt, K.M., Martin, J.A., 2000. Dynamic Capabilities: What are they?. *Strategic Management Journal*. 21(10/11), 1105-1121.
- Ellram, L.M., 1995. Partnering Pitfalls and Success Factors. *International Journal of Purchasing and Materials Management*. 31 (2), 36-44.
- Evans, S., Jukes, S., 2000. Improving co-development through process alignment. *International Journal of Operations and Production Management*. 20 (8), 979-988.
- Farr, C.M., Fischer, W.A., 1992. Managing International High Technology Co-operative projects. *R&D Management*. 22 (1), 77-95.
- Gadde, L.E., Snehota, I., 2000. Making the most of supplier relationships. *Industrial Marketing Management*. 29 (4), 305-316.
- Gupta, A.K., Souder, W.E., 1998. Key drivers of reduced cycle time. *Research Technology Management*. 41 (4), 38-43.
- Gupta, A., Wilemon, D. 1990. Accelerating the Development of Technology-based New Products?, *California Management Review*, Winter, pp. 24-44.
- Håkansson, H. (editor) 1987. *Industrial Technological Development*. London: Croom Helm.
- Håkansson, H., Eriksson, A.K., 1993. Getting innovations out of supplier networks. *Journal of Business-to-Business Marketing*, 1 (3), 3-34.
- Handfield, R.B., Ragatz, G.L., Petersen, K.J. Monczka, R.M., 1999. Involving Suppliers In New Product Development. *California Management Review*. 42 (1), 59-82.
- Hartley, J.L., 1994. Understanding supplier involvement in their customer's product development., doctoral thesis. Department of Quantitative analysis and Operations Management. University of Cincinnati.
- Hartley, J.L., Meredith, J.E., McCutcheon, D., Kamath R.J., 1997a. Suppliers' contributions to product development: An exploratory survey. *IEEE Transactions on Engineering Management*. 44 (3), 258-267.
- Hartley, Janet L., Zirger, B.J., Kamath, R.R., 1997b. Managing the buyer-supplier interface for on-time performance in product development. *Journal of Operations Management*. 15 (1), 57-70.

- Henderson, R., Clark, K., 1990. Architectural innovation: the reconfiguration of existing product technologies and the failure of established firms. *Administrative Science Quarterly*, 35 (1), 9-30.
- Imai, K., Ikujiro, N., Takeuchi, H., 1985. Managing the new product development process: how Japanese companies learn and unlearn. In R.H. Hayes, K. Clark & Lorenz (Eds.). *The uneasy alliance: managing the productivity-technology dilemma: 937-375/* Boston Harvard Business School Press
- Kamath, R.R. Liker, J.K., 1994. A Second Look at Japanese Product Development. *Harvard Business Review*. 72, 154-170.
- Lamming, R., 1993. *Beyond partnership, strategies for innovation and lean supply*. London: Prentice-Hall.
- Laseter, T.M., Ramdas, K. 2002. Product types and Supplier roles in Product development: An Exploratory Analysis. *IEEE Transactions on Engineering Management*. 49 (2), 107-118.
- Lawrence, P.R., Lorsch J.W., 1967. *Organization and Environment. Managing Differentiation and Integration*, Boston: Harvard Business School Press.
- Lewis, M., Slack, N., Twigg, D., 2001. Motivation and dynamic of Guest Engineering. *R&D Management*. 31 (4), 421-434.
- McDermott, C., Handfield, R., 2000. Concurrent Development and Strategic Outsourcing: Do the rules change in breakthrough innovation?. *The Journal of High Technology Management Research*, 11 (1), 35-57.
- Mohr, J. Spekman, R., 1994. Characteristics of partnership success: Partnership attributes, communication behavior and conflict Resolution. *Strategic Management Journal*. 15, 135-152.
- Monczka, R.B., Trent, R.J., Handfield, R.B., 1998. *Purchasing and Supply Chain Management*. Cincinnati: South-Western College Publishing. pp. 776.
- Monczka, R.M., Petersen, K.J., Handfield, R.B., Ragatz, G. 1998. Success factors in Strategic Supplier Alliances: The buying company perspective. *Decision Sciences*. 29 (3), Summer, 553-577.
- Monczka, R.M., Handfield, R.B., Scannell, T.V., Ragatz, G.L., Frayer D.L., 2000. *New product development: strategies for supplier integration*. Milwaukee: ASQ Quality Press, Milwaukee.
- Nishiguchi, T., 1994. *Strategic Industrial Sourcing: The Japanese Advantage*. Oxford University Press, New York.
- Nishiguchi, T., Ikeda, M., 1996. 'Suppliers' innovation: understated aspects of Japanese industrial sourcing', In: Nishiguchi, T. (Ed.), *Managing Product Development*. Oxford University Press, Oxford, pp. 206-232.
- Pauwels, P. 2000. *International Market Withdrawal: a strategy process study*. Thesis Limburg Universitair Centrum.

- Penrose, E., 1959. *The Theory of the Growth of the Firm*. Basil Blackwell, London.
- Pettigrew, A.M., 1973. On studying organizational cultures. *Administrative Science Quarterly*. 24, 570-581.
- Pettigrew, A.M., 1992. The Character and Significance of Strategy Process Research. *Strategic Management Journal*. 13 (Special Issue, Winter), 5-16
- Pfeffer, J. Salancik, G.R. 1978. *The External Control of Organizations, A Resource Dependence Perspective*. Harper & Row. New York.
- Primo, M.A. Amundson, S.D. 2002. An exploratory study of the effects of supplier relationships on new product development outcomes. *Journal of Operations Management*. 20 (1), 33.
- Ragatz, G.L., Handfield, R.B., Petersen, K.J., 2002. Benefits associated with supplier integration into product development under conditions of technology uncertainty. *Journal of Business Research*. 55 (5), 389.
- Ragatz, G.L., Handfield, R.B., Scannell, T.V. 1997. Success factors for integrating suppliers into product development. *The Journal of Product Innovation Management*. May, 14 (3), 190-203.
- Rubenstein, A.H., Ettlie, J.E., 1979. Innovation Among Suppliers to Automobile Manufacturers: An Exploratory Study of Barriers and Facilitators. *R&D Management*. 9 (2), 65-76
- Sako, M., 1992. *Prices, Quality and Trust: Interfirm relations in Britain and Japan*. Cambridge: Cambridge University Press.
- Schoonhoven, C.B., Eisenhardt, K.M., Lyman, K. 1990. Speeding Products to Market: Waiting Time to First Product Introduction in New Firms. *Administrative Science Quarterly*. 35 (1), 177-207.
- Smith, P.G., Reinertsen, D.G. 1998. *Developing products in half the time*. New York: Van Nostrand Reinhold.
- Sobrero, M., Roberts, E.B., 2002. Strategic management of supplier-manufacturer relations in product development. *Research Policy*. 31 (1), 159-182.
- Sobrero, M., Roberts, E.B. 2001. The trade-off between efficiency and learning in interorganizational relationships for product development. *Management Science*. 47 (4), 493-511.
- Stuart, F.I., 1997. Supplier alliance success and failure: a longitudinal dyadic perspective. *International Journal of Operations and Production Management*. 16 (10), 5-10.
- Takeishi, A., 2001. Bridging Inter- and Intra-Firm Boundaries: Management of Supplier Involvement in Automobile Product Development. *Strategic Management Journal*. 22 (5), 403-433.
- Teece, D., Pisano, G., 1994. The dynamic capabilities of the firm: An Introduction. *Industrial and Corporate Change*. 3 (3), 537-556
- Teece, D.J., Pisano, G. Shuen, A., 1997. Dynamic Capabilities and Strategic Management. *Strategic Management Journal*. 18 (7), 509-533.
- Van de Ven, A., Drazin, R., 1985. Alternative forms of fit in Contingency Theory. *Administrative*



- Science Quarterly. 30 (4), 514-539.
- Van Weele, A.J., 1999. *Purchasing Management: Analysis, Planning and Practice*. Chapman & Hall, London.
- Von Hippel, E., 1988. *The sources of innovation*. New York: Oxford University Press.
- Wasti, S.N. Liker, J.K., 1997. Risky business or competitive power? Supplier involvement in Japanese product design. *Journal of Product Innovation Management*. 14 (5), 337–355.
- Wernerfelt, B., 1984. A Resource-Based View of the Firm. *Strategic Management Journal*. 5 (2), 171-180.
- Wheelwright, S.C. Clark, K.B, 1992. *Revolutionizing Product Development: Quantum Leaps in Speed, Efficiency, and Quality*. Free Press, New York.
- Wynstra, J.Y.F., Van Weele, A.J., Axelsson, B., 1999. Purchasing involvement in product development: a framework. *European Journal of Purchasing and Supply Management*. 5 (3–4), 129–141.
- Wynstra, J.Y.F., Ten Pierick, E., 2000. Managing supplier involvement in product development: a portfolio approach. *European Journal of Purchasing and Supply Management*. 6, 49-57.
- Wynstra, J.Y.F., Axelsson, B., Van Weele, A.J. 2000. Driving and enabling factors for purchasing involvement in product development. *European Journal of Purchasing and Supply Management*. 6 (2), 129–141.
- Wynstra, J.Y.F., Van Weele, A.J., Weggeman, M., 2001. Managing supplier involvement in product development: three critical issues. *European Management Journal*. 19 (2), 157-167.
- Wynstra, J.Y.F., Weggeman, M., Van Weele, A.J., 2003. Exploring Purchasing Integration in Product Development. *Industrial Marketing Management*. 32 (1), 69-83.
- Yin, R.K., 1994. *Case study research: design and methods*. 2nd edition, Thousand Oaks: Sage Publications.
- Zirger, B.J., Hartley, J.L. 1997. The effect of acceleration techniques on product development time. *IEEE Transactions on Engineering Management*. 43 (2), 143–152.

**Table 1: Activities for managing supplier involvement in product development**

Areas	Activities	Key processes*
<b>Development Management</b>	1. Determining which technologies to keep/develop in-house and which ones to outsource to suppliers	P
	2. Formulating policies for the involvement of suppliers	C, T
	3. Formulating policies for purchasing related activities of internal departments	C, T
	4. Communicating policies and procedures internally and externally	I
<b>Supplier Interface Management</b>	5. Monitoring supplier markets for technological developments	I
	6. Pre-selecting suppliers for product development collaboration	P
	7. Motivating suppliers to build up/maintain specific knowledge or develop certain products	M, C
	8. Exploiting the technological capabilities of suppliers	C
	9. Evaluating suppliers' development performance	I
<b>Project Management</b>	<i>Planning:</i>	
	10. Determining specific Develop-or-Buy solutions	P
	11. Selecting suppliers for involvement in the development project	P, M, C, T
	12. Determining the extent ('workload') of supplier involvement	P, C
	13. Determining the moment of supplier involvement	P, T
	<i>Execution:</i>	
	14. Co-ordinating development activities between suppliers and manufacturer	C, T, I
	15. Co-ordinating development activities between different first tier suppliers	C, T, I
16. Co-ordinating development activities between first tier and second tier suppliers	C, T, I	
17. Ordering and chasing prototypes	C, T, I	
<b>Product Management</b>	<i>Extending activities:</i>	
	18. Providing information on new products and technologies being developed or already available in supplier markets	I
	19. Suggesting alternative suppliers, products and technologies that can result in a higher quality of the final product	P, M, I
	<i>Restrictive activities:</i>	
20. Evaluating product designs in terms of part availability, manufacturability, lead-time, quality, and costs	I	
21. Promoting standardisation and simplification of designs and parts	P, M, I	

**Long-term collaboration results**

- More efficient/effective future collaboration
- Access to suppliers' technology
- Technology roadmap alignment
- Transfer of solutions developed to other projects

**Short-term collaboration results**

- Part technical performance
- Part cost
- Part development cost
- Part development lead-time

P =prioritizing, M = mobilizing, C = Coordinating, T = timing I = informing,

Source: Wynstra et al., 1999.

**Table 2: Characteristics selected business units, development projects and parts**

<b>Business Unit</b>	<b>A</b>			<b>B</b>				
<b>R&amp;D dependence</b>	High			High				
<b>Supplier dependence</b>	High > Purchase value 80% of manufacturing cost			High > Purchase value 80% of manufacturing cost				
<b>Manufacturing type</b>	Medium-series based production			Medium-series based production				
<b>Business unit Size</b>	Medium sized			Medium sized				
<b>Market uncertainty</b>	Somewhat increasing competition Cost pressure lower than in other BU			Increasing competition and cost pressure in higher volume segments				
<b>Development Project</b>	<b>Star</b>	<b>Moon</b>		<b>Alpha</b>	<b>Beta</b>	<b>Gamma</b>	<b>Delta</b>	
<b>Degree of Project innovation<sup>5</sup></b>	Medium-to-High	Medium		Low-Medium	Medium-high	Low-medium	Medium	
<b>Parts</b>	<b>Optics Unit 1</b>	<b>Optics Unit 2</b>	<b>PC-based Controller</b>	<b>Paper Separation assembly</b>	<b>Optics Unit 3</b>	<b>Heater Power Supply</b>	<b>Print Receiving Unit</b>	<b>Moving Stapler Unit</b>
<b>Technical Development complexity<sup>6</sup></b>	High	High	Medium	High	High	Medium	Medium	Medium
<b>Nature/nr of different technologies</b>	Optics, Electronics Mechanics	Optics, Electronics Mechanics	Electronics Mechanics	Mechanics Rubber	Optics, Electronics Mechanics	Electronics Mechanics	Mechanics Electronics SW	Mechanics, Electronics, SW
<b>Suppliers</b>	Optico	Optico	Chain-PC	Astra	Optico	Cerel	Sorto	Motio

<sup>5</sup> The ‘degree of project innovation’ was determined using the scores of the R&D project leader and the Manufacturing Project leader, who answered the following questions respectively on a five point scale: Newness of the final product’s (1) components, (2) configuration, (3) product technologies and (4) manufacturing technologies.

We used the scores on their questions to determine the degree of project innovation: Low=1,2 Medium=3, High=4,5

<sup>6</sup> Development complexity is indicated as Low, Medium or High. It is determined by the number of different technologies and by the degree to which the part determines the specs and design of other parts. A part containing three different technologies is considered to be highly complex, while a part with two technologies is considered to be of medium complexity. A part that scored 4 or 5 is considered to be highly complex, 3 to be of medium complexity and 1,2 is of low complexity.

Table 3: Short-term and long-term collaboration results

Short-term collaboration results (1-well below target, 5-well above target)	Case 1 Optics Unit 1	Case 2 Optics Unit 2	Case 3 PC-based Controller	Case 4 Paper Separation Assembly	Case 5 Optics Unit 3	Case 6 Power Supply	Case 7 PRU	Case 8 MSU
Technical performance	2	3	2	1	2	3	3	3
Material cost	1	2	3	5	1	2	2	2
Development time	2	3	2	2	2	3	2	3
Development cost	1	3	2	2	1	3	1	2
Long-term collaboration results (Low-High)								
Improved efficiency and effectiveness of collaboration	Medium	Medium	Medium	Low	Medium-to high	Medium	Medium	High,
Improved access to supplier technology	Medium	Medium	Low	Low	Medium	High	Low	Low
Extent of aligned technology and product roadmap	Medium	Medium	Medium	N.A.	Medium	Yes,	Low	Low
Transfer of solutions developed during the collaboration to other projects (Econ. of scope)	Low	Low	Low	Low	Low	Potentially	Low	Low

**Table 4: Overview of encountered issues and problems during collaboration**

Problems/ Issues	Optics Unit 1	Optics Unit 2	PC-based Controller	Paper separation assy	Optics Unit 3	Heater Power supply	Print Receiving Unit	Moving Stapler Unit	# cases
1. Unexpected technical problems prototypes during development	✓	✓	✓	✓	✓		✓	✓	7
2. Doubts/discussion regarding supplier's assembly, test and production capabilities after collaboration started.	✓	✓	✓	✓	✓		✓	✓	7
3. Doubts/discussion regarding design capabilities of suppliers after collaboration started	✓	✓			✓		✓	✓	5
4. Transfer of design and or engineering tasks back to Océ.	✓	✓			✓		✓	✓	5
5. Doubts on correct supplier choice /lack of full internal commitment	✓		✓		✓		✓	✓	5
6. Lengthy in-project discussions on contract price elements	✓		✓		✓		✓	✓	5
7. Complex communication interface with supplier organization	✓	✓	✓		✓			✓	5
8. Transfer of assembly/testing tasks back to Océ.	✓	✓	✓		✓				4
9. Hidden specifications (specs do not match functional behavior)	✓		✓	✓	✓				4
10. Océ prescribing suppliers			✓	✓			✓	✓	4
11. Unexpected/undesirable divestment, acquisition, merger activities						✓	✓	✓	3
12. Changing first tier suppliers during project	✓		✓					✓	3
13. Part availability/supply risks/ safety stock policy	✓		✓		✓				3
14. Océ not able to limit changes in team composition			✓				✓	✓	3
15. Language/cultural differences	✓	✓			✓				3
16. Access to supplier's product and technology roadmap	✓		✓		✓				3
17. Lack of future projects/continuation at risk							✓	✓	2
18. Supplier not able to keep the same people on project team			✓					✓	2
19. Discussion on non-compatible CAD / Data Management systems							✓	✓	2
20. Océ rejecting second tier supplier choices by first tier supplier								✓	1
21. In project discussions on surpassing budgeted hours and timely communication thereof								✓	1
22. Unclear restrictive specification format			✓						1
23. (Timely) access to critical design info				✓					1
24. Discussion on warranty costs				✓					1

**Table 5: Project Management activity characteristics**

Project Management Activities	Issues/ Problems encountered	Optics Unit 1	Optics Unit 2	PC-based Controller	Paper Separation Assy	Optics Unit 3	Power Supply	PRU	MSU
<b>PJM 1</b> Determining specific Develop-or-Buy solutions	4 Transfer of design tasks 8 Transfer of assembly tasks	R&D driven, Unit identified by R&D search for black box development; Fast initial decision (4,8)	R&D driven: Project architecture driven choice (4)	R&D-marketing driven choice to choose the technology (8)	R&D driven Fast initial decision	R&D driven Standard supplier product Fast initial decision (4,8)	R&D identified the Power Supply Unit	Initially, R&D driven. Unit with clear interfaces and functional character. (4)	R&D driven Result of KIC-driven search for units for increased supplier involvement; (4)
<b>PJM 2</b> Selecting suppliers for involvement in the development project	5 Supplier choice questioned 7 Océ presenting 2 <sup>nd</sup> tier suppliers to 1 <sup>st</sup> tier supplier 13 Changing 1 <sup>st</sup> tier supplier during project 19 Océ rejecting 2 <sup>nd</sup> tier supplier choices by 1 <sup>st</sup> tier supplier	R&D driven, No real transparent cross-functional selection process. No audit in advance (5)	Purchasing involved, natural choice based on existing strategic relationship (5)	Non-transparent (multiple members) and project members). Initially barely any Purchasing involvement. More involvement in 2 <sup>nd</sup> tier supplier. No extensive audit/assessment (5,13)	Buyer was involved (late) followed standard Request For Quotation procedure	R&D driven. Some involvement of buyer. No extensive audit/assessment (5)	Joint R&D Purchasing decision. Supplier was a pre-selected supplier	No Purchasing involvement in selection of Engineering Partner. Active involvement in 2 <sup>nd</sup> tier supplier choice. No official audit/ Some management assessment (5, 7, 13)	No extensive comparison among alternative suppliers. Cross-functional Selection, No official audit. Some management assessment (5,7,19)
<b>PJM 3</b> Determining the extent (workload) of supplier involvement	2 Discussion supplier manuf. capabilities 3 Discussion supplier design capabilities 4 Transfer of design/eng tasks back to Océ 8 Transfer of assembly tasks	Initially black-box, No validation in advance (2,3,4,8)	Explicit R&D choices for standard supplier product (2,3,4,8)	Standard supplier product initially chosen No (2,8)	Implicit R&D decision. No time spent on deciding on extent of involvement: natural limited involvement	Initially Black box. Not much cross-functional validation in advance (2,3,4)	R&D and Purchasing determined Supplier involved based on potential future problem and responsible for black box development	R&D driven/Diminishing extent of involvement. No validation in advance design. Quality level design was not high in relation to desired extent of supplier involvement (2,3,4,8)	Initially Blackbox. Not much cross-functional validation (2,3,4)
<b>PJM 4</b> Determining the moment of supplier involvement	13 Changing 1 <sup>st</sup> tier supplier during project	Involvement in concept development phase; Involvement of Optico is triggered by failure previous collaboration (13)	Involvement in concept development phase	Involvement in engineering phase; Involvement of Chain PC is triggered by failure previous collaboration (13)	Involvement mid-engineering phase	Involvement in concept dev. phase; Moment is result of technical need to have proto-types to validate the functional concept	Timely Moment well in advance of project	Involvement in engineering phase Involvement of Sorriso triggered by failure previous collaboration (13)	Involvement in late concept development phase
<b>PJM 5</b> Coordinating development activities between suppliers and manufacturer	1 Unexpected technical problems with 1 <sup>st</sup> tier supplier 7 Unstable/ Complex communication interface with suppliers	Communication was initially difficult. Use of intermediary facilitated, but Océ gradually took over several design related tasks (1)	Coordination occurred via an R&D engineer from another project and the buyer. Worked well to some extent (1)	Communication difficult Many different actors on both sides involved because of validation and assembly problems (1,7)	Simple Engineer-Engineer and buyer sales person interface.	Communication was initially difficult. Use of intermediary facilitated, but Océ gradually took over several design-related tasks (1,7)	Direct and simple interface between R&D, Purchasing and supplier counterparts	Initially co-ordination did not work properly between and within the supplier organization; solved partially by arrival of 2 <sup>nd</sup> Océ engineer	> 15 persons in collaboration identified in different disciplines and managerial levels. Coordination difficult with changing team composition
<b>PJM 6</b> Co-ordinating development activities between different 1 <sup>st</sup> tier suppliers		via Océ. No active communication between two 1 <sup>st</sup> tier suppliers	via Océ. No active communication between two 1 <sup>st</sup> tier suppliers	via Océ. No active communication between two 1 <sup>st</sup> tier suppliers	via Océ. No active communication between two 1 <sup>st</sup> tier suppliers	via Océ. No active communication between two 1 <sup>st</sup> tier suppliers	via Océ. No active communication between two 1 <sup>st</sup> tier suppliers	via Océ. No active communication between two 1 <sup>st</sup> tier suppliers	via Océ. No active communication between two 1 <sup>st</sup> tier suppliers.
<b>PJM 7</b> Co-ordinating development activities between 1 <sup>st</sup> tier suppliers and second tier suppliers	10 Océ presenting 2 <sup>nd</sup> tier suppliers to 1 <sup>st</sup> tier suppliers 11 Unexpected technical problems involving 2 <sup>nd</sup> tier supplier	R&D led R&D selected Lenses at 2 <sup>nd</sup> tier supplier. Purchasing involved in discussions between R&D and 2 <sup>nd</sup> tier suppliers (11)	R&D designed PBA; arranged 2 <sup>nd</sup> tier contract manufacturer and to deliver PBA to Chain PC's assembly location	R&D selected Lenses at 2 <sup>nd</sup> tier supplier Quality control issues, payment	R&D arranged contact for regular delivery of rubber compound to 1 <sup>st</sup> tier supplier	R&D selected Lenses at 2 <sup>nd</sup> tier supplier Purchasing also involved in discussions between R&D and 2 <sup>nd</sup> tier suppliers (11)	No co-ordination necessary, except for components and increased assembly level	R&D and purchasing are somewhat involved in contacts with 2 <sup>nd</sup> tier suppliers. No substantial problems in co-ordinating these activities (10)	Océ perceives problems in development activities between Motic and PBA suppliers. No substantial problems in co-ordinating (10,11)
<b>PJM 8</b> Ordering and chasing prototypes		R&D led	R&D led	R&D led	R&D led	?	?	?	?

**Table 6: Product Management activity characteristics**

Product Management	Issues and Problems	1 Optics Unit 1	2 Optics Unit 2	3 PC-based Controller	4 Paper Separation Assembly	5 Optics Unit 3	6 Power Supply	7 PRU	8 MSU
<b>PDM 1</b> Providing information on new products and technologies being developed or already available in supplier markets	9 Hidden specifications Increasing customization	Primarily by R&D Limited <i>(Issue 9)</i>	Moderately	Moderately Info was built up during project <i>(Issue 9)</i>	No <i>(Issue 9)</i>	Info was built up and provided during project Not all available right from start <i>(Issue 9)</i>	Extensively	Limited Few readily available PRUs that could be readily integrated	Limited No supplier market for the MSU part existed. Stapler heads suppliers were readily available
<b>PDM 2</b> Suggesting alternative suppliers, products and technologies that can result in a higher quality of the final product	10 Océ prescribing 2 <sup>nd</sup> tier suppliers to 1 <sup>st</sup> tier suppliers 19 Océ rejecting 2 <sup>nd</sup> tier supplier choices by 1 <sup>st</sup> tier supplier	Limited visible contribution from Purchasing. One supplier was willing	Purchasing suggested alternative suppliers (that were already known to R&D)	Limited contribution from purchasing; grew in subsequent projects <i>(10)</i>	No alternatives were actively investigated in this project. Purchasing involved after concept choice was fixed <i>(10)</i>	Limited contribution from Purchasing. R&D investigated 2 potential alternative technologies	Purchasing and R&D consulted two alternative suppliers in the existing supply base	Purchasing made suggestions in the 2 <sup>nd</sup> round 2 <sup>nd</sup> R&D – engineer suggested alternative 2 <sup>nd</sup> tier suppliers and technologies <i>(10)</i>	R&D and Purchasing considered a limited set of alternative suppliers <i>(10, 19)</i>
<b>PDM 3</b> Evaluating product designs in terms of part availability, manufacturability, lead-time, quality, and costs	1 Unexpected technical problems during development 6 Lengthy discussions on different part cost elements 8 Transfer of manufacturing tasks back to Océ. 14 Part availability /supply risks/ safety stock policy 22 Timely access to design info		Actual evaluation feedback by Purchasing and Engineer from other project <i>(1)</i>	R&D leading for technical aspects, Purchasing and Manufacturing confronted with part availability and quality issues. <i>(1,6,14, 22)</i>	R&D leading for technical aspects. Dominant focus on technical problems <i>(1,14)</i>	R&D leading for technical aspects Long evaluation times. Persistent risks on all evaluation dimensions Long transition period towards production <i>(1,6)</i>	R&D leading for evaluating functional performance Purchasing evaluated costs. Manuf Eng discussed Assembly issues Long transition period towards production <i>(1)</i>	R&D leading for technical aspects strong VA focus Purchasing evaluated final cost and part availability. Fast prototyping; Long transition period towards production <i>(1,6)</i>	R&D leading for technical aspects including part availability Long pauses between intensive evaluation cycles. Long transition period towards production <i>(1, 6)</i>
<b>PDM 4</b> Promoting standardization and simplification of designs and parts	9 Hidden specifications 21 Unclear restrictive specification format	Not actively pursued, Achieving functional performance was leading <i>(9)</i>	Striving for standard product Result somewhat customized design	R&D and Purchasing strove for standard supplier product halfway through the project. Customized part was the result <i>(9, 21)</i>	Partial standardization pursued Functional problems and chosen concept inhibit simplification and standardization	Not actively pursued. Achieving functional performance was leading <i>(9)</i>	Not actively pursued, customized design	Supplier and Océ strongly focus on simplified design and parts	Not actively pursued

**Table 7: Development Management activity characteristics**

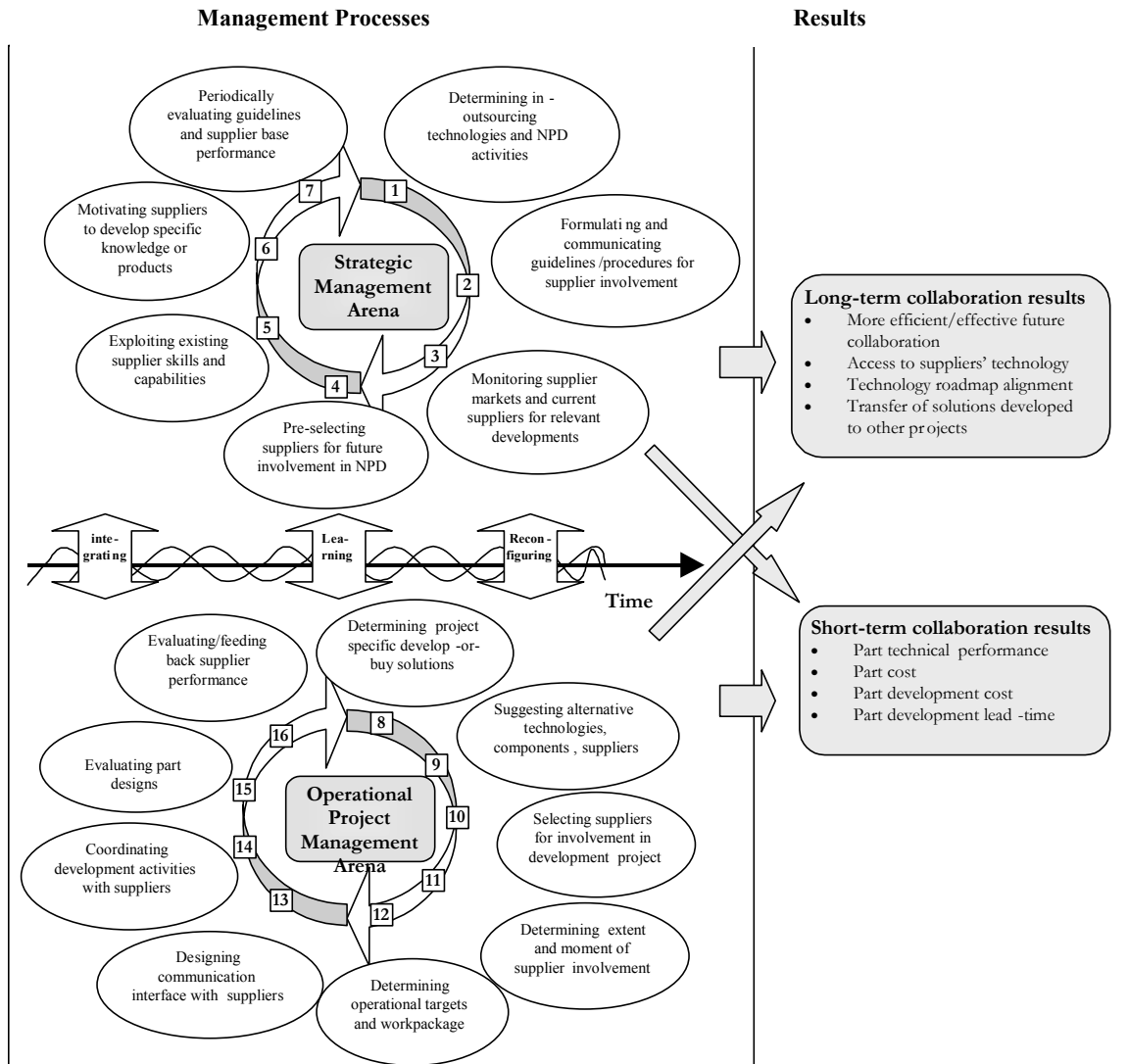
Development Management Activities	Business Unit A and B	1	2	3	4	5	6	7	8
		Optics Unit 1	Optics Unit 2	PC-based Controller	Paper separation assy	Optics Unit 3	Heater Power supply	Print Receiving Unit	Moving Stapler Unit
		Degree of support to Project and Product Management							
<b>DM -1</b> Determining Technology In-Outsourcing policy	<ul style="list-style-type: none"> <li>▪ Basic statement: 'We buy unless...'</li> <li>▪ Clear in-outsourcing policy regarding specific core copying/printing/ technologies</li> <li>▪ Large variations at other levels in product architecture and technologies</li> <li>▪ Relatively large project autonomy and situational decision making in engineering and assembly in outsourcing decisions</li> <li>▪ Several cross-project initiatives started. Many are not perceived as successful.</li> <li>▪ Some commodity-specific initiatives are taken. Electronics commodity buy parts / IT technologies</li> </ul>	Low	Low	Low	Low	Low	High	Low	Low
<b>DM -2</b> Formulating policies for the involvement of suppliers in product development	<ul style="list-style-type: none"> <li>▪ Limited nr of guidelines available</li> <li>▪ Océ technical design standards were described but not specifically for suppliers.</li> <li>▪ ISO 9001 process descriptions and guidelines available at Manufacturing and Purchasing</li> </ul>	Low	Low	Low	Low	Low	Medium	Low	Low
<b>DM -3</b> Formulating policies for IPDS-related activities of internal departments	<ul style="list-style-type: none"> <li>▪ A steadily growing number of internal procedures. Some specific routines have emerged, which may not always reflect the official steps in procedures, e.g. supplier selection.</li> <li>▪ Examples of procedures relating to supplier involvement component Release Process, Purchasing Portfolio used in development projects.</li> </ul>	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
<b>DM -4</b> Communicating policies and procedures internally and externally	<ul style="list-style-type: none"> <li>▪ Barely</li> <li>▪ Initially high-level introduction of Océ organization and project phasing.</li> <li>▪ Supplier finds procedures and organization complex</li> </ul>	Low	Low	Low	Low	Low	Low	Low	Low



**Table 8: Supplier Interface Management activity characteristics**

Management Activities	Business Unit A and B	1	2	3	4	5	6	7	8
		Optics Unit 1	Optics Unit 2	PC-based Controller	Paper separation	Optics Unit 3	Power supply	Print Receiving Unit	Moving Stapler Unit
		Degree of support to Project and Product Management							
<b>SIM 1</b> Monitoring supplier markets for technological developments	<ul style="list-style-type: none"> <li>▪ Generally project triggered and strongly R&amp;D driven;</li> <li>▪ Purchasing had 2 specialists for core copying technologies</li> <li>▪ Monitoring is not permanent driving force due to high operational workload</li> <li>▪ Some production technologies specialist groups have been active in both Purchasing and R&amp;D. (Rubber, Sheet metal, Plastic molding)</li> <li>▪ Separate and joint Purchasing-R&amp;D market research.</li> <li>▪ Ad-hoc and informal scanning is now supported. by Monitoring function via an International Purchasing Office</li> <li>▪ R&amp;D scans intentionally regulatory developments; Purchasing involvement gradually increased.</li> </ul>	Low	Low	Low	Low	Low	High	Low	Low
<b>SIM 2</b> Pre-selecting suppliers	<ul style="list-style-type: none"> <li>▪ Approved Supplier List introduced during the 1990s, no emphasis on innovative /engineering capabilities.</li> <li>▪ R&amp;D developed since mid-1990s a list of preferred suppliers in collaboration with Purchasing for certain electronics commodities</li> <li>▪ Purchasing categorization introducing 'Higher Level Systems Buying suppliers'.</li> <li>▪ IT-hardware and Software partner policy since mid-nineties.</li> </ul>	Low	Low	Low	Low	Low	Medium	Low	Low
<b>SIM 3</b> Motivating suppliers	<ul style="list-style-type: none"> <li>▪ No formal routine; Problem triggered motivation efforts</li> <li>▪ A variety of occasions and ways of motivation emerge for different commodities, technologies and suppliers</li> </ul>	Medium	Medium	Medium	Low	Medium	High	Medium	Low
<b>SIM 4</b> Exploiting suppliers' technical capabilities	<ul style="list-style-type: none"> <li>▪ Limited</li> <li>▪ Attempts within certain commodities are made to opt for existing technologies and standard supplier products when designing products, however strong tendency to end up with customer-specific designs and parts.</li> </ul>	Low	Low	Low	Low	Low	Low	Low	Low
<b>SIM 5</b> Evaluating suppliers' development performance	<ul style="list-style-type: none"> <li>▪ Ad hoc evaluation</li> <li>▪ Few direct evaluation with suppliers</li> <li>▪ Some overall project-based evaluation initiatives</li> <li>▪ Evaluation of supplier development performance is not formalized</li> <li>▪ Limited value of using supplier audit tool as an evaluation tool for NPD purposes.</li> </ul>	Low	Low	Low	Low	Low	Low	Low	Medium

Figure 1: Revised framework





Eindhoven Centre for Innovation Studies

## WORKING PAPERS

Ecis working papers 2003 / 2004:

- 03.01 A. Nuvolari  
*Open source software development: some historical perspectives*
- 03.02 M. van Dijk  
*Industry Evolution in Developing Countries: the Indonesian Pulp and Paper Industry*
- 03.03 A.S. Lim  
*Inter-firm Alliances during Pre-standardization in ICT*
- 03.04 M.C.J. Caniëls & H.A. Romijn  
*What drives innovativeness in industrial clusters? Transcending the debate*
- 03.05 J. Ulijn, G. Duysters, R. Schaezlein & S. Remer  
*Culture and its perception in strategic alliances, does it affect the performance? An exploratory study into Dutch-German ventures*
- 03.06 G. Silverberg & B. Verspagen  
*Brewing the future: stylized facts about innovation and their confrontation with a percolation model*
- 03.07 M.C. Caniëls, H.A. Romijn & M. de Ruijter-De Wildt  
*Can Business Development Services practitioners learn from theories on innovation and services marketing?*
- 03.08 J.E. van Aken  
*On the design of design processes in architecture and engineering: technological rules and the principle of minimal specification*
- 03.09 J.P. Vos  
*Observing Suppliers observing Early Supplier Involvement: An Empirical Research based upon the Social Systems Theory of Niklas Luhmann*
- 03.10 J.P. Vos  
*Making Sense of Strategy: A Social Systems Perspective*
- 03.11 J.A. Keizer & J.P. Vos  
*Diagnosing risks in new product development*
- 03.12 J.M. Ulijn, A. Fayolle & A. Groen  
*European educational diversity in technology entrepreneurship: A dialogue about a culture or a knowledge management class?*

- 03.13 J.M. Ulijn, S.A. Robertson, M. O’Duill  
*Teaching business plan negotiation: How to foster entrepreneurship with engineering students*
- 03.14 J.E. van Aken  
*The Field-tested and Grounded Technological Rule as Product of Mode 2 Management Research*
- 03.15 K. Frenken & A. Nuvolari  
*The Early Development of the Steam Engine: An Evolutionary Interpretation using Complexity Theory*
- 03.16 W. Vanhaverbeke, H. Berends, R. Kirschbaum & W. de Brabander  
*Knowledge management challenges in corporate venturing and technological capability building through radical innovations*
- 03.17 W. Vanhaverbeke & R. Kirschbaum  
*Building new competencies for new business creation based on breakthrough technological innovations*
- 03.18 K.H. Heimeriks & G.M. Duysters  
*Alliance capability as mediator between experience and alliance performance: an empirical investigation into the alliance capability development process*
- 03.19 G.M. Duysters & K.H. Heimeriks  
*Developing Alliance Capabilities in a New Era*
- 03.20 G.M. Duysters, K.H. Heimeriks, J. Jurriëns  
*Three Levels of Alliance Management*
- 03.21 B. Verspagen & C. Werker  
*The invisible college of the economics of innovation and technological change*
- 03.22 W. Vanhaverbeke, B. Beerkens, and G. Duysters  
*Explorative and exploitative learning strategies in technology-based alliance networks*
- 03.23 S.J. van Dijk, G.M. Duysters & A.J.M. Beulens  
*Transparency dilemmas, information technology and alliances in agriculture and food industry*
- 03.24 S.J. van Dijk & M.P.C.D. Weggeman  
*Knowledge sharing in technology alliances*
- 03.25 C. Castaldi & A. Nuvolari  
*Technological Revolutions and Economic Growth: The “Age of Steam” Reconsidered*
- 03.26 A. Nuvolari, B. Verspagen and N. von Tunzelmann  
*The Diffusion of the Steam Engine in Eighteenth-Century Britain*
- 03.27 L. Wang & A.S. Szirmai  
*Technological Inputs and Productivity Growth in China’s High-Tech Industries*
- 04.01 B. Nooteboom & V.A. Gilsing  
*Density and strength of ties in innovation networks: a competence and governance view*
- 04.02 A. Nuvolari  
*Collective invention during the British Industrial Revolution: the case of the Cornish pumping engine*
- 04.03 C. Meister & B. Verspagen  
*European Productivity Gaps: Is R&D the solution?*
- 04.04 J.J. Berends, J.D. van der Bij, K. Debackere, M.C.D.P. Weggeman  
*Knowledge sharing mechanisms in industrial research*

- 04.05 J.J. Berends, K. Debackere, R. Garud, M.C.D.P. Weggeman  
*Knowledge integration by thinking along*
- 04.06 Ho, M.H.C  
*Differences between European Regional Innovation Systems in terms of technological and economic characteristics*
- 04.07 Echtelt, F.E.A., Wynstra, J.Y.F, Weele van, A.J., Duysters, G.M  
*Critical processes for managing supplier involvement in new product development: an in-depth multiple-case study*