Service orientations of manufacturing companies : impact on new product success

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Impact on New Product Success

Michael D.J. Antioco

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en
prof.dr. R.K. Moenaert

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dr. A. Lindgreen

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Table of Contents

List of Tables

List of Figures

List of Appendices

Chapter 1

Introduction to the Studies

1.1. Introduction

Today's business reality leads us to acknowledge the importance of services in the manufacturing industry. Companies such as Caterpillar, Philips Medical Systems, Siemens, Xerox, and many others are diversifying their business by offering services in order to remain competitive (Wise and Baumgartner, 1999). However, due to the specific nature of services (Edgett and Parkinson, 1993), effectively managing services may require manufacturing firms to change in terms of structure, strategies, and communication (Bowen, Siehl, and Schneider, 1989; Goldstein, Johnson, Duffy, and Rao, 2002; Mathieu, 2001). Manufacturers need to effectively understand, integrate, and manage services in order to actually benefit from service orientation.

Lytle, Hom, and Mokwa (1998, p. 459) formally define a service orientation as "*an organization-wide embracement of a basic set of relatively enduring organizational policies, practices, and procedures intended to support and reward service-giving behaviors that create and deliver services excellence.*" The objective of this dissertation is thus to tackle the following broad questions relating to service orientations. First, how can manufacturing companies effectively implement service orientations (Homburg, Hoyer, and Fassnacht, 2002)? Second, what are the consequences of implementing service orientations on the success of products and services commercialized by manufacturers, as well as on product design decision-making?

The dissertation is organized in three core chapters, which address this call for research (i.e. Homburg et al., 2002) at different levels of analysis: organizational, functional, and individual. Hereunder follow the rational, methodology, and contribution of each study. In-

depth theoretical and managerial *raisons d'être* for each study are provided in chapters two through four.

1.1.1. Service Orientation at the Organizational Level of Analysis – Chapter 2

The objective of this chapter is to define organizational dimensions and service strategies that help explain service profitability and relative product success in manufacturing companies. Implementing a service business strategy requires that manufacturers offer a good selection of services, to a broad customer base, and in a pro-active manner (Homburg et al., 2002). Our aim is to identify – based on literature and in-depth interviews – organizational parameters that will significantly affect the support for service business strategies (Lytle, et al., 1998). Past research studied such organizational parameters in the service and banking industry (e.g. Johnston, 1996). In the retailing industry, research has been carried out on the implementation of service business strategies (Homburg et al, 2002). Combining the fragmented literature, we draw an integrated model within the manufacturing sector. Further, making a distinction between two different service business strategies, we observe their consequences on service profitability and relative product success in the market. We formulate our research questions as follows:

- *RQ1*: What are the organizational parameters that significantly increase the support for service business strategies in manufacturing companies?
- *RQ2*: Do *both* service strategies equally influence relative product success?
- *RQ3*: Do *both* service strategies equally enable manufacturing companies to reach service profitability?

In order to answer these research questions, we surveyed service managers of international manufacturing companies located in Northern Europe. More precisely, these firms were located in Belgium, the Netherlands, and Denmark. We used PLS-Graph Version 3.0

(Chin, 2001) to obtain partial least squares (PLS) estimates of the structural parameters in our structural equation model (SEM) (Chin, 1998; Falk and Miller, 1992; Hulland, 1999). Further, chapter two also discusses theoretical and managerial implications of our findings, as well as research limitations.

1.1.2. Service Orientation at the Functional Level of Analysis – Chapter 3

Chapter three addresses our broad research question at the functional level of analysis. This study seeks to identify antecedents to the use of service-sourced information (USSI) by the design-engineering department and the consequences of the USSI on product and service characteristics. We surveyed design-engineering managers involved in day-to-day design activities of manufacturing companies located in the U.S.

First, our objective is to explain *why* design engineers form positive or negative attitudes toward the service department and the feedback information they receive from this department. The fact that product design has been found to influence both the amount of service support required and the way it can be delivered (Goffin, 2000) confers relevance to this research question. Therefore, creating a healthy design/service interface appears to make sense.

Second, we examine the relationships between the USSI by design engineers and the consequences on product and service characteristics. Our results will demonstrate the essentiality of managing relationships between design and service employees. This study adds to the existing literature advocating the importance of cross-functional communication for new product and service success (e.g. Griffin and Hauser, 1996). As in chapter two, we used PLS-Graph Version 3.0 (Chin, 2001) to tackle our structural model. From our findings, we establish clear rules that will assist manufacturing companies in managing the design/service interface. Our research questions are formulated as follows.

- *RQ4*: What are the antecedents of the USSI by design engineers in their day-to-day design activities?
- *RQ5*: What are the consequences of the USSI by design engineers in their day-to-day design activities on product and service characteristics?

1.1.3. Service Orientation at the Individual Level of Analysis – Chapter 4

In chapter four, we establish how communication networks and functional membership – through professional culture – influence on-going product design decisions (PDD). PDD refer to the extent to which employees are willing to adapt, refine, or enhance the design of a commercialized product (Song and Montoya-Weiss, 1998).

Previous studies have mostly tackled functional communication between dyads (De Ruyter and Wetzels, 2000; Gupta, Raj, and Wilemon, 1986; Moenaert, De Meyer, Souder, and Deschoolmeester, 1995; Moenaert and Souder, 1990) or triads (Ruekert and Walker, 1987; Song, Montoya-Weiss, and Schmidt, 1997). Also, these studies mainly measured the frequency of communication at a functional level without making further precisions on the communication patterns of the constituent individuals embedded in the organization. Moreover, most of these findings are based on the assumption of equality of influence between the various departments during on-going product decision-making. That is, each department involved in new product development brings a fair contribution to the construction of the product. This study evaluates *relative* functional dominance in, and the consequences on, the decision-making process within a manufacturing company. In order to do so, we use social network analysis (SNA) (Borgatti, Everett, and Freeman, 1999; Iacobucci and Hopkins, 1992), which enables us to unravel informal patterns of communication behavior, and thus informal power influences (Powell, Koput, and Smith-Doerr, 1996).

Also, we establish why manufacturers decide to proceed with product re-designs in the technical stage of new product development. Past research and in-depth interviews within a manufacturing company lead us to the identification of go/no-go decision criteria considered when evaluating the eventuality to proceed with a product's technical development.

Based on research findings pertaining to the influence of organizational sub-cultures on interpretations and strategies for actions (Howard-Grenville, 2006), we posit that functional membership and communication network positions will influence on-going product design decision-making. We will answer the following research questions in chapter 4:

- RQ 6: Which go/no-go decision criteria are evaluated by manufacturing firms during on-going product design decisions?
- RQ 7(a): To what extent does functional membership influence the concern for go/no-go decision criteria manufacturing firms use to make on-going product design decisions?
- RQ 7(b): To what extent does functional membership influence on-going product design decisions?
- RQ 8: Which employees are central during product information exchanges within the manufacturing organization?
- RQ 9: Which employees are knowledge creators and absorbers during product information exchanges within the manufacturing organization?
- RQ 10: Does employee degree centrality during product information exchanges lead to more favorable on-going product design decisions?
- RQ 11: Does employee degree centrality during product information exchanges lead to higher experimental learning?
- RQ 12: Is there an inverted U-shaped function between the amount of experimental learning and on-going product design decisions?

The SNA was carried out in a manufacturing company that provides solutions to customers in four main business areas: baggage handling, express parcel, distribution, and services. Due to the nature and the high response rate imperatives of such data collection, one-site sampling is not uncommon in SNA (Tsai and Goshal, 1998). We demonstrate that counter to individual perceptions of R&D and operations engineering employees, the service personnel is still not effectively included in on-going product decision-making. Also, we show that functional membership and network positions significantly influence decision-making. Therefore, we propose guidelines for product-team composition that will help manufacturers reduce potential decision bias during on-going PDD. We show that the inclusion of service employees in PDD can significantly reduce decision bias.

1.2. Epistemological Paradigms of the Research Dissertation

Guba and Lincoln (1984, 105) define a paradigm as the "*basic belief system or world view that guides the investigation.*" Based on the work of Guba and Lincoln (1994) and Christie, Rowe, Perry, and Chamard (2000), we present in Table 1 a conceptual schema for categorizing scientific research paradigms.

For each research project we carried out, the exploratory phase is embedded in the *realism* paradigm (Christie, et al., 2000). Realists are concerned with real-world phenomena that cannot be perfectly and probabilistically apprehended (Perry and Coote, 1994). Perry (1998) notes that realism is characterized by a certain degree of investigator objectivity in opposition to constructivism. The in-depth interviews carried out to explore the reality are particularly appropriate for the study of events that are focused on a situation or a context that has been specified. Indeed, each of our research projects entails existing (adapted) constructs relating service orientation to product success, service success, and product decision-making. Our aim is thus to "*attempt to understand the nature of the*

research problem reflecting, forming, and revising meanings and structures of the phenomena being studied" (Christie et al., 2000, 12).

Table 1. Conceptual Schema for Categorizing Scientific Research Paradigms

Item	Positivism	Critical Theory	Constructivism	Realism
Ontology	Reality is real and apprehensible	Virtual reality shaped by social economics, ethnic, political, and cultural values crystallizes over time	Multiple local and specific constructed realities	Reality is 'real' but only imperfectly and probabilistically apprehensible and so triangulation is required to know it
Epistemology	Objectivistic: finding true	Subjectivistic: value mediated findings	Subjectivistic: findings are created	Modified objective: findings probably true with awareness of values between them
Methodology	Verification of hypotheses, mainly quantitative methods	Researcher is a transformative intellectual who changes the social world within which participants live	Researcher is a 'passionate participant' within the world being investigated	Case Studies/Interviews: interpretation of research issues by qualitative and quantitative methods

However, such approaches to research are always partly affected by the researcher's subjectivity (Tiétard, 1999). Therefore, spanning from the exploratory phase, we induct deterministic hypothesis that will confirm or infirm the causality between our focal constructs and their antecedents and consequences. This confirmatory approach finds its justification in the *positivistic* paradigm, where the formal logic is a deductive one (Thiétart, 1999). According to positivists, this is the only logic enabling an objective reproduction of the reality (Thiétart, 1999). With this approach, we acquire legitimacy by significantly increasing the external validity of our findings. Also, to demonstrate internal consistency, we verified for common method variance (Lindell and Whitney, 2001), which confirmed that the relationships hypothesized were not erroneously inflated. Table 2 gives an overview of the three empirical studies.

Table 2: Overview of the Research Studies

Chapter	Dependent Measures	Methodology	Sample (Usable)	Suggested Readings
2	Service Profitability and Relative Product Success	Qualitative in-depth interviews and Quantitative survey design (PLS)	137 service managers (EU)	Homburg et al., 2002; Lytle et al., 1998
3	Product and Service Characteristics	Qualitative in-depth interviews and Quantitative survey design (PLS)	121 design engineers (USA)	Griffin and Hauser, 1996; Atuahene-Gima and Evangelista, 2000; Moenaert and Souder, 1996
4	Support for go/no-go decision criteria and Product Design Decisions	Qualitative in-depth interviews and Quantitative survey design (SNA)	54 network actors within a manufacturing company (NL)	Achrol, 1997; Carbonell, Rodriguez, and Munuera, 2004; Hutt, Reingen, and Ronchetto, 1989

Chapter 2

Organizational Antecedents and Consequences of Service Business Strategies in Manufacturing Companies

2.1. Abstract

Although product manufacturers across sectors increasingly develop into total solution providers, no research has yet been carried out on service orientations in the manufacturing sector. We define the organizational dimensions and service business strategies that help explain service profitability and relative product success in manufacturing companies. An empirical study in 137 firms in the Netherlands, Belgium, and Denmark demonstrates the importance of service rewards, service technologies, top management commitment and visionary leadership for the implementation of service business strategies. Furthermore, we find that offering delivery, maintenance, and repair services relates significantly to a higher service profitability but not to relative product success on the market. Financial and consulting services do not significantly increase the service profitability, but influence the relative success of manufacturers' products. Also, cross-functional communication between service employees and the rest of the firm increases relative product success, but does not influence organizational support for service business strategies. The managerial and research implications are discussed.

2.2. Introduction

Accounting for 60% of U.S. industrial production in 2001 (Federal Reserve, 2002), durable manufactured products require services as they advance through their life cycles. Rapid technological changes, diminishing product life cycles (Berg and Loeb, 1990), and fast time to market requirements (Goffin, 1998; Homburg, Hoyer, and Fassnacht, 2002; Lele, 1986) pressure many manufacturers to remain competitive. Product innovation solely is not adequate anymore to guarantee business success. Thus, extending tangible products with related support/field services makes sense in terms of gaining and maintaining a competitive advantage (Nambisan, 2001; Wise and Baumgartner, 1999). In effect, some manufacturers—including Caterpillar, Hewlett-Packard, IBM, Philips Medical Systems, Siemens, and Xerox— position themselves as total solutions providers.

Although the importance of services in the Western economies has been acknowledged and documented, no empirical research has investigated the impact of an adjustment of structure and strategy on service profitability and relative product success in manufacturing companies. There clearly exists a compelling need to acquire fine-grained, research-based insight in this aspect of manufacturing competitiveness: Cespedes (1994), Goffin (2000), Homburg, Hoyer, and Fassnacht (2002), Johnson, Menor, Roth, and Chase (2000), Nambisan (2001), and Mathieu (2001) all recently demonstrated the need to study service strategies and their consequences in manufacturing firms. Indeed, the study of the service orientation of organizational parameters in the banking (Johnson, 1996; Lytle, Hom, and Mokwa, 1998) and retailing industries (Homburg et al., 2002) has not been extended to the manufacturing sector.

From the (fragmented) literature – and facilitated by in-depth interviews – the authors develop a theoretical model on the impact of organizational parameters (i.e., corporate parameters; Homburg et al., 2002) and service business strategies on relative product

success and service profitability. The extant literature and contemporary business practices show that manufacturers offer two main types of support services; those in support of the product and those in support of the client (Mathieu, 2001). This is a factor that was not taken into account when the levering power of services was associated to product success (Grönroos, 1998). Hence, as part of our theoretical contribution, it is interesting to establish whether both types of support services equally influence relative product success and service profitability. Our aim is thus to answer the following three research questions:

- *RQ1*: What are the organizational parameters that significantly increase the support for service business strategies in manufacturing companies?
- *RQ2*: Do *both* service strategies equally influence relative product success?
- *RQ3*: Do *both* service strategies equally enable manufacturing companies to reach service profitability?

The chapter is structured as follows: First, we discuss the research framework and elaborate on the service orientation of the business strategy in manufacturing companies. Second, we hypothesize about the impact of organizational drivers and the service orientation of the business strategy on service profitability and relative product success. Third, we derive managerial implications from our findings.

2.3. Research Framework and Hypotheses Development

Lytle et al. (1998, p. 459) formally define a service orientation as *"an organization-wide embracement of a basic set of relatively enduring organizational policies, practices, and procedures intended to support and reward service-giving behaviors that create and deliver services excellence."* In reality, interest in service orientations is relatively new. It first emerged when Bowen et al. (1989) called for research that could compare the characteristics of service and manufacturing firms. However, research on service

orientation has only recently been embraced at a team and corporate level in the banking (Johnson, 1996; Lytle et al., 1998) and retailing (Homburg et al., 2002) sectors.

In an exploratory phase, we carried out seven in-depth interviews with service managers in the following industries: medical equipment, electronics manufacturing, machinery and heavy equipment, and information technology (IT). The sample was limited, but carefully chosen. All companies were large or medium-sized manufacturing firms, competed on a global scale, and demonstrated a strong interest in including services as part of their business offerings. The purpose of the interviews was twofold: to assess the importance of field service for manufacturing firms and to hear the *voice of the market* (i.e., managers) concerning eventual organizational changes and business strategies that have been implemented to support the offering of services.

2.3.1. Focal Construct: Service Orientation of the Business Strategy

The service orientation of the business strategy refers to (1) the number of services offered, (2) how many customers receive it, and (3) how proactively the company emphasizes the service offering (Homburg et al., 2002). Thus, at its very extreme, a low service orientation of the business strategy will be the consequence of a modest service offering proposed to few customers in a non-proactive manner.

Regarding the number of services offered by the manufacturer, we need to make an important distinction between *services in support of the supplier's product* (e.g., maintenance, repair) (SSP) and *services in support of the client's actions* (e.g., training, financing services, consulting services) (SSC) (Mathieu, 2001). These two services contrast sharply on the dimensions outlined by Lovelock (1991), i.e the nature of the service, the recipient of the service, the relationship between the firm and its customers, and the level of service customization. SSC are – in contrast with SSP - characterized by

an intense relationship between the seller and the buyer, a high degree customization, and an emphasis on people as recipients of the service as the predominant variable of interest (Mathieu, 2001).

2.3.2. Antecedents to the Service Orientation of the Business Strategies

Due to a service's intrinsic properties, the service development process can be more complex than that for products because service components represent *"a combination of processes, people skills, and materials that must be appropriately integrated to result in planned or designed service"* (Goldstein, Johnson, Duffy, & Rao, 2002, p. 121). While new service development follows the same underlying structure as new product development, the relative importance of each stage is affected by the unique characteristics of services (Edgett and Parkinson, 1993) – namely, intangibility, inseparability, heterogeneity, and perishability. In addition to the resources needed to support service offerings, the increased complexity of the overall offering (both tangible product and intangible services) creates functional interdependencies that require effective management (Cespedes, 1994). Finally, effective service firms rely heavily on climate and cultural mechanisms, such as shared service norms and values (Bowen, Siehl, & Schneider, 1989). This holds important implications for the organization and its employees: *"services require organizational principles, capabilities, metrics and incentives … the emphasis of the business model changes from transaction- to relationship-based."* (Oliva & Kallenberg, 2003, p. 161). Based on the literature and the in-depth interviews, we distinguish four organizational parameters, which we posit will positively relate to the service orientation of business strategies in industrial manufacturing firms.

2.3.2.1. Cross-Functional Communication of Service Employees

Organizations cannot truly lever from service offerings when the service climate is confined to the service department. Service norms, values, and inputs must be shared with the rest of the firm through service communication in order to optimize the combination of processes, people, and materials (Goldstein, Johnson, Duffy, & Rao, 2002). As two service managers mentioned in our interviews:

> "*The service department is finally considered during decision making related to product development because we possess a lot of market information even if we still feel that it is a bit too late [in the process]. Top management is currently working on this. It is also helping us improve service delivery because we are dependent on other departments"* (Services manager; IT manufacturing)

> "*I think engineers are starting to value our opinion…. They see that we know those products as well as they do. We also work on those products…. More and more, we can participate in meetings about new products and don't just send out information about product defect rates or mean time to repair for example*." (Services director; electronics manufacturing)

The importance of a department in an organization can be assessed by its centrality in communication flows (Achrol, 1997). The literature on cross-functional teams has convincingly demonstrated the importance of breaking up internal functional boundaries if employees are to profit from one another's expertise and insight. Essentially, cross-functional communication refers to "*interdependency and information sharing between the various organizational units"* (Song, Montoya-Weiss, and Schmidt, 1997, p. 37). It has been linked to the increased likelihood of positive new product performance (Song, Montoya-Weiss, and Schmidt, 1997), the effectiveness of new product and service

development (Lievens and Moenaert, 2000), product quality (Menon, Jaworski, and Kohli, 1997), product innovativeness (Sethi, Smith, and Park, 2001), and the increased ability to cope with complex and dynamic environments (Huber, 1982). Combining the importance of cross-functional teams with the perspectives on communication networks (Achrol, 1997), we posit that cross-functional communication about customers, competitors, and product development between the service department and the rest of the firm represents a significant organizational parameter for the establishment of service business strategies. We put forward that service employees' interactions with other employees will positively impact 'service awareness' in the manufacturing organization, which in turn will positively facilitate organizational support for both service business strategies.

H1: The more cross-functional communication there is between service employees and the rest of the firm, the higher the service orientations of the SSP and SSC business strategies will be.

2.3.2.2. Rewards for Service Behavior

The activities of recruiting, developing, and rewarding employees are the core activities of the HR department. During organizational change, the role of the HR department is to *"utilize various recruiting and training & development techniques to attract the best talent possible that will support this changing structure"* (Rowden, 2002, p.158). HR activities in manufacturing firms should be critical for the support of service business strategies given the importance of people in the new service development process (Cooper & Kleinschmidt, 1987; Johne & Storey, 1998) and the inherent differences between service and product personnel. Due to the 'physical and psychological' proximity/inseparability between the producers (i.e., service employees) and the consumers of the service (Bowen and

Schneider, 1998, p. 65), appropriate HR policies should increase the support for service business strategies.

Rynes (1991, p. 429) defines recruitment as encompassing *"all organizational practices and decisions that affect either the number, or types, of individuals who are willing to apply for, or accept a given vacancy."* Effective recruitment is critical to organizational success (Carlson, Connerley, & Mecham, 2002). Furthermore, people perform better in a rewarding workplace (Allen & Helms, 2002; Tyagi, 1990). Thus, beyond the choice of staff and training that have been studied in relation to organizational change (Rowden, 2002), the presence of service reward systems are crucial (Edvardsson & Olsson, 1996). Such reward systems represent the recompense for service-oriented work. Our interviews corroborate earlier findings in the organizational behavior literatures: HR practices have an important impact on the quality of the service offering (Heskett, Sasser, & Schlesinger, 1997; Johnson, 1996).

> "*If you want people to start acting differently, you have to explain to them what you want. People also need to feel that their efforts will be rewarded, especially contact employees because they deal with all the customers' problems, basically. They [contact employees] are the first people in the escalation procedure if our products go wrong and they need to do their job well.*" (Services director; medical equipment manufacturing)

In the context of the search of cost efficiencies and economies of scales, which are important drivers in manufacturing cultures (Jelinek and Goldhar, 1983), the implementation of rewards for service behavior may be overseen. By rewarding service behaviors, manufacturers explicitly create awareness of service importance, and therefore, create a favorable atmosphere for service 'philosophy'. At the same time, it encourages

service employees to establish contacts with other departments (Froehle et al., 2000; Edvardsson, Thomasson, and Ovretveit; 1994). Therefore, we posit:

H2: The higher rewards are for service behaviors, the higher the service orientations of the SSP and SSC business strategies will be.

H3: The higher rewards are for service behaviors, the more cross-functional communication between service employees and the rest of the firm there will be.

2.3.2.3. Information and Communication Technologies

Information and communication technologies (ICTs), such as e-mail and an intranet, play important roles in finding, processing, and sending information effectively (Nonaka and Teece, 2001). Moreover, they enable those people who probably would not otherwise have communicated to do so. According to previous research, service providers that introduce new service products more rapidly than others have a significantly better control over their IT infrastructure (Froehle et al., 2000; Menor, Roth, and Mason, 1998), which is necessary to build a service system to deliver excellent service quality (Zeithalm and Bitner, 2000). ICTs therefore enable better service delivery, as well as the collection and processing of information. As a result, we include ICTs (Lytle et al., 1998), and more specifically the creation and use of an accessible database of customer-related information (Coviello et al., 2002), as a key organizational parameter leading to higher service cross-functional communication and service business strategies.

H4: The higher the use of ICTs is, the higher the service orientation of SSP and SSC business strategies will be.

H5: The higher the use of ICTs is, the more cross-functional communication between service employees and the rest of the firm there will be.

2.3.2.4. Top Management Commitment and Visionary Leadership to Services

The pivotal role of top management in new product development has been extensively demonstrated in the science-based literature on innovation. Top management's posture influences new product success (Souder and Jenssen, 1999), intraorganizational technology diffusion (Pae et al., 2002), and the degree of and need for organizational integration (Millson and Wilemon, 2002). Appelbaum, St-Pierre, and Glavas (1998) also adhere to this line of thinking in their work on organizational change. As formulated by Sureshchandar et al. (2001, p. 382) in reference to Edvardsson, Thomasson, and Ovretveit 's (1994) work, "*service leadership is the art of leading and espousing a mental, strategic, and spiritual change in the organization and simultaneously initiating and accomplishing practical changes and ensuring that they are systems and measures."* We suggest that top management's well-founded strategic role can also be extended to this research context. We point forward that the higher TMC is, the higher the support for service strategies and the more the feel within the organization of an important push towards establishing organizational service practices will be. We thus posit that TMC will be linked positively to the support for service rewards, the use of service ICTs, and the cross-functional communication of service employees. First, by reaching a critical mass, manufacturers will create more service orientation across the organization. Second, by expressing and demonstrating support for strategic imperatives and procedures (Ruekert and Walker, 1987), manufacturers put explicit and/or implicit pressure on the organization to 'servitize' the lower level/operational organizational parameters (factors 1 to 3). This influence is what Millson and Wilemon (2002) identify as the link between management 'philosophy' and the degree of service integration. The underlying individual mechanism explaining this relationship is that the beliefs of top management will integrate the beliefs of employees;

the opinion of a large group of people (of reference) cannot be wrong (Venkatesh and Davis, 2000). Therefore, we hypothesize:

H6: The stronger top management's commitment and visionary leadership to services is, the higher the service orientation of SSP and SSC business strategies will be.

H7: The stronger top management's commitment and visionary leadership to services is,(a) the more cross-functional communication between service employees and the rest of the firm there will be, (b) the higher rewards for service behaviors will be, and (c) the higher the service orientation of ICTs will be.

2.3.3. Consequences of the Service Orientation of the Business Strategies

2.3.3.1. Relative Product Success and Service Profitability

Our objectives are twofold. First, we aim to demonstrate the importance of service cross-functional communication on relative product success. Second, we re-examine in light of recent service literature the impact of service business strategies on new product success; as well as on service profitability. Product success is the extent to which manufacturing firms can attain market share and generate high sales volume with the commercialization of the product (Hultink and Atuahene-Gima, 2000). Essentially, and as mentioned previously, cross-functional communication has been linked to the increased likelihood and effectiveness of new product development, performance, and quality (Lievens and Moenaert, 2000; Menon, Jaworski, and Kohli, 1997; Song, Montoya-Weiss, and Schmidt, 1997, p. 37). Previous studies have mostly tackled functional communication between dyads (Gupta, Raj, and Wilemon, 1986; Moenaert, De Meyer, Souder, and Deschoolmeester, 1995; Moenaert and Souder, 1990) or triads (Ruekert and Walker, 1987; Song, Montoya-Weiss, and Schmidt, 1997). However, none of these studies include service employees. Past literature found that the development – and more specifically the design –

of manufacturing products has been found to influence both the amount of service support required and the way it can be delivered (Goffin, 2000; Lele, 1986). Also, several authors have highlighted the importance of service inputs for the organization (e.g. Berry and Parasuraman, 1997; Sampson, 1996; Voss, Roth, Rosenzweig, Blackmon, and Chase, 2004). Therefore, we hypothesize that the cross-functional communication of service employees during product development will enhance the success of the product on the market.

H8: The more cross-functional communication between service employees and the rest of the firm there is, the higher the relative product success in the market will be.

Augmenting tangible products with support services appears to be fundamental in increasing both customer satisfaction (Lele and Sheth, 1988) and perceived product quality (Grönroos, 1998). Service offerings, due to the interactivity between the service supplier and customers that they provide, and service support, through the adaptation of organizational parameters, can create long-term relationships between the parties involved in the market exchange. Manufacturers that pursue more long-term relationships with their customers will likely create higher relative customer satisfaction and loyalty, which leads to higher profitability (Anderson and Narus, 1990; Morgan and Hunt, 1994). Due to the nature of SSC, their ability to develop relationships, and given that they are less common than SSP, we posit the following relationships: the higher the support for SSC strategies, the higher relative product success and the higher the service profitability of manufacturers will be. As such, the positive relationship between service offering and product success has been observed before (Grönroos, 1998); however, the distinction between the impact of SSC and SSP strategies has not. Indeed, we posit a nonsignificant association between the support for SSP strategies and relative product success, and service profitability. The

spread of SSP offerings in the manufacturing sector has as a potential consequence their loss of a relative advantage on helping manufacturers sell their products and create profits from SSP services. Moreover, SSP offerings are characterized by lower relationship intensity, fewer customization possibilities, and less emphasis on people than on SSC (Mathieu, 2001).

H9: The higher the service orientation of SSC business strategies is, the higher (a) the relative product success and (b) the higher service profitability will be.

H10: There is no significant relationship between the service orientation of SSP business strategies and (a) the relative product success and (b) service profitability.

2.4. Methodology

2.4.1. Data Collection

Data was collected using survey research. Following the qualitative exploratory phase, we developed a questionnaire for conclusive testing of the hypotheses. We contacted 15 companies for our pretest. We then e-mailed the respondents to the pretest and asked the service managers whether they were able to answer our questions and if the survey needed to be clarified. For five services, supplementary precision was needed. These clarifications appear in parenthesis in the right column of Table A in the appendix.

Empirical data were collected from manufacturing companies located in Belgium, Denmark, and the Netherlands. These three northern European countries are of roughly similar population sizes, have strategic locations, and host the two largest harbors for the export of manufacturing products in Europe. The presence of large harbors has attracted a large number of manufacturing factories and offices for logistics reasons. Indeed, according to 2000 census data, all three countries have gross operating surpluses in turnover in the manufacturing sector slightly superior to the European average (Eurostat,

2002). Also, the Royal Danish Ministry of Foreign Affairs (2002) and the Belgian Federal Government–Portail Fédéral (2004) have both acknowledged the importance of the industrial sector for their economies.

We collected data in seven industry segments—heavy machinery (including heavy medical equipment), automotive manufacturing, construction, electrical manufacturing, manufacturing of heavy and precision electronics, IT and telecom, and mechanical manufacturing—which we chose on the basis of the listing of the manufacturing industry presented by the European Commission and the *Financial Times*.

In Belgium, 211 manufacturers were contacted. All service managers received an e-mail with a link to our survey, which had been professionally translated and back translated into Dutch, English, and French (Brislin, 1980). After two e-mail reminders, 56 managers completed the survey online (26.5%). In the Netherlands, the survey also was e-mailed with a choice of answering the survey in Dutch or English, whereas in Denmark, due to time and financial constraints, the survey was available only in English. In fact, English is the working language in a large proportion of companies in Denmark. This procedure resulted with 54 responses in the Netherlands (19.9%) and 41 in Denmark (19.6%). In total, we received 151 surveys collected from service managers, service directors, and service vice presidents of manufacturing firms. Due to the nature of this study, fourteen companies that had fully outsourced their services were not included in the sample. This left us with a sample of 137 usable questionnaires. Early (first 75%) and late respondents (last 25%) were compared according to Amstrong and Overton's (1977) recommended procedure. Early and late respondents did not differ in their support for service orientations, customer value, and firm value indicating that non-response bias was not an issue.

Each respondent was asked to answer the survey by referring to those products commercialized in and the practices related to their primary industry segment, which we defined as the segment that generates the majority of the net sales or contract revenues for their company. All managers were promised an executive summary of the findings, as well as a chance to compare their performance with that of others in the same industry segment. Respondents were also assured confidentiality.

2.4.2. Measurements

We used PLS-Graph Version 3.0 (Chin, 2001) to obtain partial least squares (PLS) estimates for both the measurement and the structural parameters in our structural equation model (SEM) (Chin, 1998; Falk and Miller, 1992; Hulland, 1999). A component-based SEM approach, PLS path modeling does not require multivariate normal data, places minimum requirements on measurement levels, and is more suitable for small samples (Chin, 1998; Fornell and Bookstein, 1982). Moreover, PLS can more easily accommodate the use of formative indicators than can covariance-based SEM (Chin, 1998; Hulland, 1999). To ensure that our sample size was adequate for the analysis, we conducted a power test, as proposed by Cohen (1988), for the *F*-test, relating R^2 for the endogenous constructs. Assuming a medium effect size (f^2 = 0.15; R^2 = 0.13) for four predictors, a significance level (α) of 0.05 and a desired power (1 – β) of 0.80 for our analysis would require a sample size of 84. Using Green's (1991) approach yielded a required sample size of 81. Both figures are well within the bounds of the sample size we obtained.

All measures were adapted from existing scales, as referenced in appendix II. Appendix III presents whether the scales are reflective or formative. The easiest way to approach reflective and formative indicators is by theoretically and practically identifying the construct's domain (Jarvis et al., 2003). In this study, only the scales measuring service

business strategies are formative. Service business strategy, similar to Homburg et al. (2002), is measured by asking whether the manufacturer offered each service in the service list, the number of customers that received this service, and the extent to which the company emphasized the services. Given that we gathered information across industries, we needed to propose a list of SSP and SSC that could fit every manufacturing industry. It would not make sense to disadvantage a company for not offering a field service if no other competitor in that industry segment did so. Therefore, we also made sure that each field service on the list was offered by at least one firm in each industry segment. To build this list, we consulted work by Homburg et al. (2002), Lovelock (1983, 1991), Mathieu (2001), and Oliva and Kallenberg (2003), as well as (customer) service managers. Appendix I presents the list of services identified and validated by practice in both service categories.

Using the list of 20 different services, we measured the broadness and emphasis of the offers on a seven-point Likert type scale when the service is offered. Because the number of services is an additive measure (0–12 for SSP, 0–8 for SSC), we convert this measure to a seven-point scale similar to that used for broadness and emphasis. Next, PLS enables us to formalize the three components of business strategy as a formative construct since they, together, enable to establish the support for business service strategies.

In addition, PLS path modeling allows us to assess the psychometric properties of the measurement instruments. In particular, we can examine their reliability, convergent validity, and discriminant validity (Chin, 1998; Fornell and Bookstein, 1982; Tenenhaus, Vinzi, Chatelin, and Lauro, 2005). We tested a measurement model without structural paths in PLS-Graph version 3.0 (Chin, 2001), which is analogous to confirmatory factor analysis in covariance-based SEM. To demonstrate convergent validity by inspecting the factor loadings of the measures on their respective constructs (Chin, 1998; Tenenhaus et

al., 2005), every item should have a standardized loading that exceeds 0.5 (Peterson, 2000). That criterion was respected (See appendix III).

The reliability of the measures was assessed using composite reliability and average variance extracted (AVE) (see appendix III). Composite scale reliability ranged from 0.910 to 0.934, exceeding the cut-off value of 0.7 suggested by Nunally and Bernstein (1994). The AVE ranged from 0.669 to 0.865, which exceeds the 0.5 cut-off value proposed by Fornell, Bookstein, and Larcker (1981). Also, we assessed discriminant validity by examining whether a construct shared more variance with its measures than with other constructs in the model (Chin, 1998, Howell and Avolio, 1993). The square root of the AVE should exceed the construct intercorrelations in the model. As Table 4 reveals, construct intercorrelations in the model did not exceed the square root of the AVE.

We also included covariates such as firm age, size in terms of the number of employees, revenues, and the service delivery mode (fully or partly delivered) to observe whether these factors influenced the dependent measures of relative product success and service profitability.

Finally, and since our data was collected using a survey questionnaire, we verify for common method variance (CMV), which may have inflated the relationships estimated between (1) the antecedents to service strategies and service strategies and between (2) service strategies and their consequences. We used the approach of Lindell and Whitney (2001) to address this issue. Lindell and Brandt (2000) and Lindell and Whitney (2001) posit that the smallest correlation with a theoretically unrelated variable is a judicious estimate of common method variance. Then, for all bivariate correlations the effect of the smallest correlation (r_s) needs to be partialled out in order to remove the effect of CMV. However, our survey questionnaire did not contain such a theoretically unrelated construct. Therefore, we took a slightly different approach by selecting the smallest correlation

among our theoretical variables. This is the correlation between the 'relative product success' and 'service profitability' ($|r_s|$ = .022). From our application of the procedure, we conclude that for all significant effects of the antecedents on service strategies and the consequences on service strategies, the corresponding bivariate correlation coefficients remain statistically significant at $p < .05$ after adjusting for CMV. Therefore, we may conclude that the effects due to CMV are negligible in our study.

2.5. Analysis and Results

To test the effects and statistical significance of the parameters in the structural model, we used a bootstrapping procedure with 250 resamples with individual sign preprocessing (Chin, 1998, 2001; Efron and Tibshirani, 1993).

2.5.1. Sample Description

In Table 4, we present the corpographics per industry segment. We tested for differences between the support for a service orientation of the service strategies between all pairs of industry segments (with more than 10 companies) and observed no significant differences. Furthermore, all industries are witnessing high customer demands for field services (M = 5.63; SD = 1.03) and field service offerings by competitors (M = 5.01; SD = 1.40). We observed no significant differences between industries, which confirms overall service importance. In Table 3, we present findings relating to the mean support, standard deviations, and correlations of our measures.

Table 3: Descriptive and Correlation Matrix*

	Mean	S.D.	TMC	SOSSP	SOSSC	SCFC	STECH	SREW	RPS	SPROF
TMC	4.69	1.27	***0.894***							
SOSSP	2.75	1.38	0.379	N/A						
SOSSC	1.12	0.87	0.264	0.608	N/A					
SCFC	4.66	1.22	0.315	0.235	0.147	***0.818***				
STECH	5.10	1.38	0.348	0.429	0.349	0.396	***0.920***			
SREW	4.32	1.15	0.350	0.349	0.335	0.384	0.403	***0.865***		
RPS	3.99	1.55	0.326	0.212	0.233	0.220	0.229	0.265	***0.930***	
SPROF	3.11	2.38	0.233	0.251	0.102	0.051	0.200	0.175	-0.022	N/A

*Notes: Square root of average variance extracted on the diagonal. TMC: Top Management Commitment and Visionary Leadership to Services; SOSSP: Service Orientation of SSP Strategy; SOSSC: Service Orientation of SSC Strategy; SCFC: Cross-Functional Communication of Service Employees; STECH: Service Orientation of Technology; RPS: Relative Product Success; SREW: Rewards for Service Behavior; SPROF: Service Profitability.

Table 4: Description of the Manufacturers per Industry Segment

	Machinery	Automotive	Construction	Electrical	Electronics	IT/Telecom	Mechanical	Missing
% of respondents	28.5 %	3 %	10.6 %	8.6 %	17.2 %	12.6 %	16.6 %	2.9 %
Average age	26 years	20 years	25 years	22.5 years	23 years	17.5 years	24 years	37.5 years
Median number of employees	130	175	40	105	150	72	61	N/A
Average revenue (million $US)	24.5	80	13	24.5	31	21.5	13	14
Percentage of revenue generated by services	18 %	20 %	14.7 %	12 %	20 %	35.6 %	18.4 %	22.5 %

2.5.2. Antecedents and Consequences of Service Orientation

Overall, we find that the focal constructs are well explained by our predictors (R^2 for SSP strategies = 0.26; R^2 for SSC strategies = 0.19; R^2 for cross-functional communication = 0.24). Together, these constructs explain ten percent of the variance for the relative success of manufacturing products and seven percent of the variance for service profitability. As such, this is a contribution to the existing studies explaining relative product success (e.g. Hultink and Atuahene-Gima, 2000) and service profitability (e.g. Froehle et al, 2000). Hereunder, we present the statistical outcome of our hypotheses and discuss them in the next section.

The first hypothesis is not supported. Indeed, we find that cross-functional communication between service employees regarding customer-, competitor-, and product-related issues neither influences the support for SSC strategies (β = -0.07, $p > 0.05$) nor the support for SSP strategies (β = -0.01, $p > 0.05$).

Hypothesis 2 is supported by the data. Service rewards significantly influence the support for SSP (a) (β = 0.157, $p < 0.05$) and SSC strategies (b) (β = 0.221, $p < 0.05$). This is also the case regarding the influence of service rewards on the cross-functional communication behaviors of service employees with the rest of the firm (H3) (β = 0.231, $p < 0.05$).

Hypotheses 4 and 5 are supported. The service orientation of technology significantly influences the support for both service strategies (H4a and H4b) (SSP: β = 0.291, $p < 0.01$; and SSC: β = 0.245, $p < 0.01$); as well as service cross-functional communication (H5) (β = 0.252, $p < 0.01$).

Hypothesis 6 is only partially supported. TMC significantly influences the support for SSP strategies (β = 0.227, $p < 0.01$) but does not have a direct significant effect on the support for SSC strategies (β = 0.125, $p > 0.05$). Hypothesis 7 is fully supported. Top

management significantly influences all lower-level/operational organizational parameters (β rewards = 0.350, $p < 0.01$; β technology = 0.348, $p < 0.01$; β cross-functional communication = 0.147, $p < 0.05$). Overall our antecedents to service business strategies explain, respectively, 26% and 19% of the variance for SSP and SSC strategies.

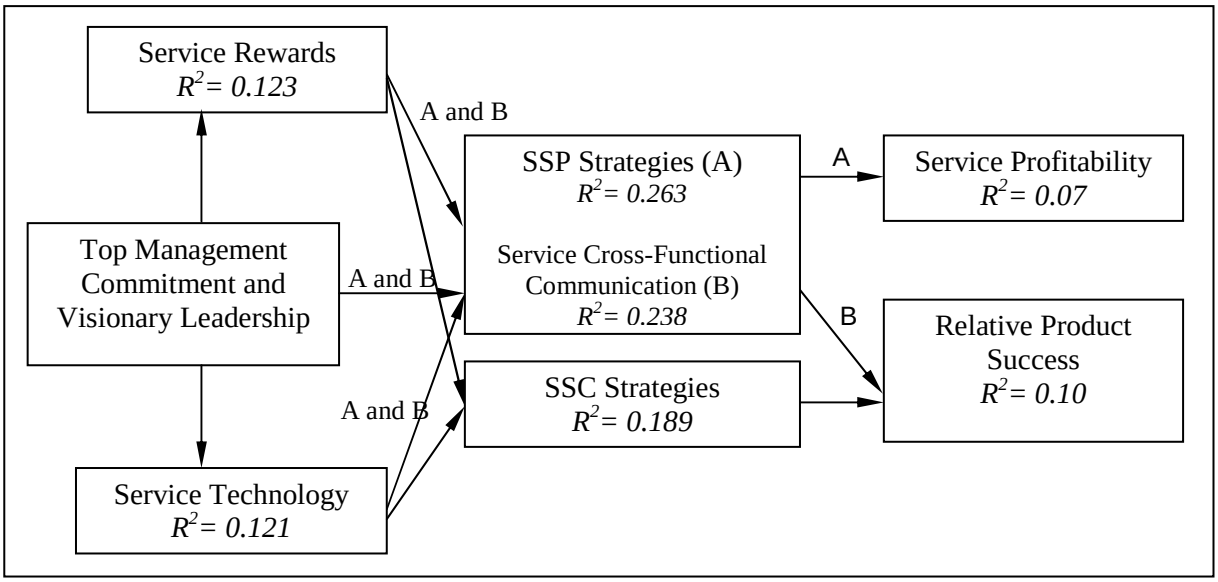
What about service business strategies and cross-functional communication as drivers of relative product success and service profitability? Cross-functional communication of service employees during the product development process is significantly associated with the relative success of the product ($\beta = 0.180$, $p < 0.05$). (H8) Clearly, the service department should not be overseen in new product development processes. However, the influence of service business strategies is somewhat different than hypothesized. Hypothesis 9 is only partially supported; the higher the support for SSC strategies, the higher the relative success of the product on the market (H9a) ($\beta = 0.165$, $p < 0.05$). On the other hand, we note that the relationship between SSC strategies and service profitability (H9b) is not significant ($\beta = -0.08$, $p > 0.05$). For SSP services, our findings demonstrate the opposite. This signifies that H10(a) is supported, while H10(b) is rejected and counter to hypothesized. As postulated, manufacturers do not increase *relative* product success with the implementation of SSP strategies ($\beta = 0.07$, $p > 0.05$); however, the higher the support for SSP strategies, the higher the service profitability ($\beta = 0.299$, $p < 0.01$). We explain respectively ten and seven percent of the variance for product success and service profitability with the service orientation in manufacturing firms.

Additionally, we performed the Sobel (1982) test to verify that our mediating variables – SSP, SSC, and service cross-functional communication – carry the influence of organizational parameters on relative product success and service profitability. Our results of the test do not confirm the full-mediation of (1) SSP strategies between service rewards and service profitability ($z = 1.59$, $p = 0.11$); (2) cross-functional communication of service

employees between TMC and relative product success (z = 1.26, p = 0.20); and (3) SSC strategies between TMC and relative product success (z = 1.42, p = 0.15). Including the direct effects suggested by Sobel's (1982) test in our empirical model leads to an R^2 of ten percent for service profitability and 14 % for relative product success. Overall though, from the added direct effects, only the direct link between TMC to services and relative product success remains significant at the .05-level (β = 0.251, $p < 0.05$).

In terms of control variables, older firms have significantly higher SSP strategies (F = 3.69, $p < 0.05$). Manufacturers' revenues do not significantly influence the support for SSC strategies (F = 2.78, $p > 0.05$); nor the support for SSP strategies (F = 2.83, $p > 0.05$). The findings also show that service profitability is not significantly different with variations in age (F = 0.957, $p > 0.05$), revenues (F = 2.25, $p > 0.05$), or delivery modes (F = 0.02, $p > 0.05$). However, smaller manufacturers have slightly higher service profitability (F = 4.26, $p < 0.05$).

Figure 1: Antecedents and Consequences of Business Service Strategies[a]



Service Rewards → SSP Strategies: 0.157*; Communication: 0.231*; SSC Strategy: 0.221*
Top Management → SSP Strategies: 0.227**; Communication: 0.147*; Rewards: 0.350**; Technology: 0.348**
Service Technology → SSP Strategies: 0.291**; Communication: 0.252**; SSC Strategy: 0.245**
SSP Strategy → Service Profitability: 0.299**
Cross-functional Communication → Relative Product Success: 0.180*
SSC Strategy → Relative Product Success: 0.165*
*: significant at the 0.05-level; **: significant at the 0.01-level.
a. Only the significant links are shown.

To conclude our structural analysis of the model, we calculated its goodness of fit (GoF), which refers to Tenenhaus et al.'s (2005) global fit measure for PLS. In this context, GoF ($0 \leq GoF \leq 1$) is defined as the geometric mean of the average communality; because the communality equals the AVE extracted in the PLS approach, we propose a cut-off value of 0.5 (Fornell and Larcker, 1981). Moreover, in line with the effect sizes for R^2 (small 0.02; medium 0.13; large 0.26) proposed by Cohen (1988), we derive the following GoF criteria for small, medium, and large effect sizes of R^2: 0.1, 0.25, and 0.36. Our GoF index reaches 0.308.

2.6. Discussion and Managerial Implications

The objectives of this research were the following. First, to enable scholars and manufacturers establish the importance of service orientations for the success of products and service profitability. Second – in light of literature on service classification (Mathieu, 2001) – to evaluate the extent to which existing literature on the lever effects of support services could be moderated. Third, to establish a clearer picture on how, and via which services, manufacturing organizations could increase their service profitability. We discuss our findings and managerial implications in three different themes.

2.6.1. Top Management's Critical Role in Supporting Services

Our findings show that service strategies, in a complementary manner, enable manufacturers to increase their relative product success and service profitability. In order to reach a service orientation of organizational parameters, manufacturers can simply not ignore the role of top management. Re-formulated: if service directors wish to increase the number of services offered, the pro-activeness of the offer, and enlargen the customer base, they must imperatively convince top management that the organization will profit from

services and commit it to implementing service leadership. Thus, the present study shows that top management's role in manufacturing firms must be extended. At the operational level, it directly influences the support for service rewards, the use of service ICTs, and the support for SSP strategies. Also, as in previous studies on cross-functional communication between other departments (Millson and Wilemon, 2002), TMC to services leads to service employees' integration via an increased communication with the rest of the firm. This in turn influences relative product success. Also, mediated by service rewards and service technology, TMC indirectly influences the support for SSC strategies. We suggest that the support for SSC strategies could be directly influenced by customer demand or competitor offerings (Narver and Slater, 1990). One interviewee partly confirmed this:

> "*Offering those services is really an important step for us. It is really saying that we are becoming a service firm. Also, I think that product-firms really start offering services like credit or consulting for two reasons. One, they really need to make their offer more attractive on a market where they can't always keep up with the technology. But, second, if our competitors start offering these services, we need to make sure that we do as well.*" (Services director; medical equipment manufacturing)

The implementation of a service orientation in manufacturing organization could be subject to resistance in companies where professional cultures are still largely dominated by R&D and operations departments (Pearson, 1990; Stainsby, 1992; Webb and Morgan, 1992). A professional culture *"exists when a group of people employed in a functionally similar occupation share a set of norms, values, and beliefs related to that occupation."* (Sirmon and Lane, 2004). According to Taylor (1988), resistance to change can stem from different sources, including human nature, fear, misunderstanding, and a situation assessment. For example, Clemons, Thatcher, and Row (1995) observe that the greater the proposed strategic reorientation, the greater the potential for redistribution of power and

thus the greater the internal conflict among different departments. Ultimately, people protect the value of their existing competencies and oppose valuable change. In order to facilitate change, past research has suggested that manufacturers should (1) invite employees to participate in organizational and strategic reorganizations and (2) establish a trust relationship between the employees and the leaders responsible for change (Lines, Selart, Espedal, and Johansen, 2005). Service departments, in order to effectively reduce potential internal resistance, should make it a priority to create commitment to services among top management. This implies that service employees should: (1) demonstrate how service strategies can relate to the overall goal of the organization, (2) define how to implement service strategies and define success criteria, and finally (3) establish how top management can personally gain by supporting service strategies (Fottler, 1977).

2.6.2. A Service is not any Service

Both academic literature and managers gain knowledge from our findings regarding the impact of service strategies. We show that higher support for SSP strategies leads to higher service profitability. However, this is not the case for SSC strategies.

We can explain these findings as follows. Higher support for SSP strategies and the nature of these services (less customization, directed to a product, and less relational) could result in better manageability of service costs and revenues; engendering higher service profitability. It is likely that manufacturing companies have been offering basic support services such as delivery and repair for a longer time than SSC since they more naturally blend in the product/service bundle (Mathieu, 2001). Past experience, explained by learning curve effects (Levin, 2000), would then lead to a better knowledge of costs encountered during servicing and, therefore, more effective pricing.

It appears that offering more so-called "higher value-added" services, which are priced relatively higher than basic services due to their nature, does not create higher service profitability. Many factors could explain this finding; the lack of experience with such service offerings, strong competition with financial institutions (i.e. banks) for the offer of financial services, as well as with regular consulting firms for service such as logistics services or process management (i.e., Boston Consulting Group). Also, there are probably more hidden costs in the delivery process of SSC than SSP due to the customization of the service, the complexity of the task, and customer expectations (Rhian, 2001). *A posteriori*, we tested whether the SSC strategy could follow an invert U-shaped relationship with service profitability. Due to the nature of SSC, could it be advisable to concentrate on fewer services, which would be offered with high pro-activeness to many customers? Our data demonstrate that it does appear to be the case. However, the influence of SSC strategies on relative product success is significant, whereas it is not the case for SSP strategies.

A service is clearly not any service. Manufacturers profit from SSP strategies and we recommend continuing offering these services to clients in a pro-active manner. They are expected by customers (Parasuraman, 1998) even though we show that they do not create relative, or additional, product success. Where the lever effects of SSC has been demonstrated on relative product success, we call – in the next section – for future research on explaining which factors may affect the relationship between the intensity of the SSC offer and service profitability.

2.6.3. The Issue of Cross-Functional Communication

The value of cross-functional communication for organizations has been extensively demonstrated (Huber, 1982; Menon, Jaworski, & Kohli, 1997; Sethi, Smith, & Park, 2001). However, should this be moderated?

The idea behind hypothesis 1 was that, by creating corporate service awareness via cross-functional communication, manufacturing organizations would influence the support for both service business strategies. Besides, by involving service employees in new product development, these could directly increase the array of support service offerings and the pro-activeness with which they would be offered. Even though cross-functional communication has proven important for organizations, our hypothesis was not supported. Service communication may lead to increased awareness, understanding, and integration of functional activities at the operational level without directly influencing manufacturing service business strategies, which are taken at a higher level within the organization. Following our lines of thinking, manufacturers might also be lead into believing that service integration via cross-functional communication during product development will increase the support for service business strategies. This finding reinforces the importance of (a) top management's role and (b) other organizational parameters for the support of service business strategies in this research context.

However, we must remark that the relationship between cross-functional communication and the development of service strategies may be affected by "strategy-making modes". In fact, three modes exist – i.e., deductive, inductive, and compressive management – for which the involvement of top management and employees vary (Nonaka, 1988). In the deductive management mode, strategy making is top-down and entails, therefore, high levels of central planning and low levels of employee involvement. This could explain the absence of relationship between the involvement of service

employees in product development activities and the support for services business strategies.

Also, the absence of relationship between the cross-functional communication of service people and the support for service business strategies may be due to service intangibility, which can cause communication barriers. Indeed, the more intangible the object of communication is, the more difficult the communication about the object becomes (Moenaert and Souder, 1990). By extensively integrating service and other functions within the organization, manufacturers may create additional difficulties in transforming service ideas into service offerings. This thus remains an avenue for future research.

Lastly, since past research proved that top management functional diversity has a positive effect on strategic orientation (Auh & Menguc, 2005), we can however recommend that manufacturing firms include a service manager in the strategic decision-making team.

2.7. Research Limitations

Our study has some limitations, the first of which pertains to the sample of manufacturers that we chose. Even though seven manufacturing industries were represented, which did not show significant differences in their support for service business strategies, our data were collected in Belgium, Denmark, and the Netherlands only. Although the majority of the manufacturers in our sample were international firms, the northern European context may have influenced the extent of support for service business strategies. The influences of national culture and economy openness have previously been shown to influence corporate behavior (i.e., Varsakelis, 2001). Industrial firms located in northern European countries may be more, or less, open to change than those located in other countries; therefore,

leading to more, or less, propensity towards the support of service business strategies. Furthermore, and more importantly, the list of SSP and SSC needed to be sufficiently universal to apply across industries. Although the list is exhaustive, studying one or a limited number of industries might enable more precision in the service inventory listing. Lastly, this study used the key informant method. Even though we verified that our respondents were well qualified to answer the survey questionnaire, limitations of key informant method have been documented (Philips, 1981). Also, it is a possibility that respondents' perceptions of the service business strategies may differ from those of customers – especially regarding the proactiveness of the service offerings. Also, disparities in perceptions may occur for relative product success. Indeed, past research demonstrated that such differences may exist between employees and customers regarding the interpretation of field feedback information (Petkova, 2003). An in-depth qualitative approach would enable us to examine whether such disparities exist.

Chapter 3

Antecedents and Consequences of Integrating Service and Design in Manufacturing Companies

3.1. Abstract

Product design influences both the quantity and the quality of service delivered on manufactured products, so it makes sense for designers to use field service feedback information to design new products. The aim of this study is to identify the antecedents and evaluate the consequences of the use of service-sourced information (USSI) by design engineers on product and service characteristics. An empirical study of 121 design engineers demonstrates that creating a healthy working relationship between design and service engineers is crucial because it motivates designers to use the service-sourced information disseminated to them. The USSI influences both relative product characteristics and service responsiveness and reliability. Second, design engineers value written information most. Attitudes toward electronic information decrease after an optimum communication frequency of once to three electronic exchanges per week. Third, information about product ergonomics positively influences designers' perceptions of the information, whereas information on product aesthetics negatively influences their perceptions. We also discuss some managerial implications of the findings, as well as avenues for further research.

3.2. Introduction and Research Background

According to research by Deloitte Consulting (1998), using a sample of 900 manufacturing executives, product innovation alone is no longer sufficient to guarantee business success for manufacturers. In addition, technological superiority is becoming increasingly difficult to maintain as a strategy (Grönroos, 1998), and maintaining low prices appears equally challenging (Zeithaml and Bitner, 2000).

Accounting for 60% of the U.S. industrial production in 2001 (Federal Reserve, 2002), durable manufactured products require services as they advance through their life cycles. The extension of tangible products through related support/field services makes sense in terms of gaining and maintaining a differential advantage (Gadiesh and Gilbert, 1998; Nambisan, 2001; Wise and Baumgartner, 1999). Field services in support of the product include delivery, installation, repair, contractual and non-contractual maintenance, inspection/diagnosis, refurbishing, condition monitoring, upgrades, and product disposal (Lovelock 1983, 1991; Mathieu, 2001; Oliva and Kallenberg, 2003).

Augmenting a tangible product with such services appears to be fundamental in increasing both customer satisfaction (Lele and Sheth, 1988) and customer perceptions of product quality (Grönroos, 1998). However, the design of such products has been found to influence both the amount of service support required and the way it can be delivered (Goffin, 2000; Lele, 1986). These are significant findings for manufacturers given that product design determines the large majority of manufacturing costs (Miller, 1988; Ullman, 1992).

The objective of this study is to evaluate the extent to which support service employees who deliver services for manufactured products can influence the design of new products and the consequences of doing so. Are firms moving away from the simple addition of support services and toward managing the feedback from field service technicians to

achieve better product (re)-design? If so, does this shift have an impact on product and service characteristics? We conceptualize our focal construct as 'USSI', which is to the extent to which the design-engineering department (DED) uses service-sourced information to design new products. Subsequently, we evaluate the consequences of USSI on product and service characteristics. Finally, we derive managerial implications from our findings. Our contribution to the existing body of literature consists of responding to the need to study 'services' in manufacturing firms (Goffin, 1998; Goffin, 2000; Johnson et al., 2000; Nambisan, 2001); and more specifically, to investigate integration mechanisms between the DED and the support service department. Therefore, our research questions are:

- *RQ4*: What are the antecedents of the USSI by design engineers in their day-to-day design activities?
- *RQ5*: What are the consequences of the USSI by design engineers in their day-to-day design activities on product and service characteristics?

3.3. Theory and Hypotheses Development

Our hypotheses development employs a two-step approach. First, we consulted literature in the areas of information dissemination (Maltz and Kohli, 1996), cross-functional communication (Atuahene-Gima and Evangelista, 2000), and attitude formation, as well as its relationship with behavior (Fishbein and Ajzen, 1975). By integrating a large body of literature, we confer a solid multidisciplinary background on our research. Second, in an exploratory phase, we carried out eight in-depth interviews; four with service managers and four with design engineers in four large and medium-sized manufacturing firms. The manufacturers belonged to the following industries: transportation, computer manufacturing, electronics manufacturing, and machinery and heavy equipment

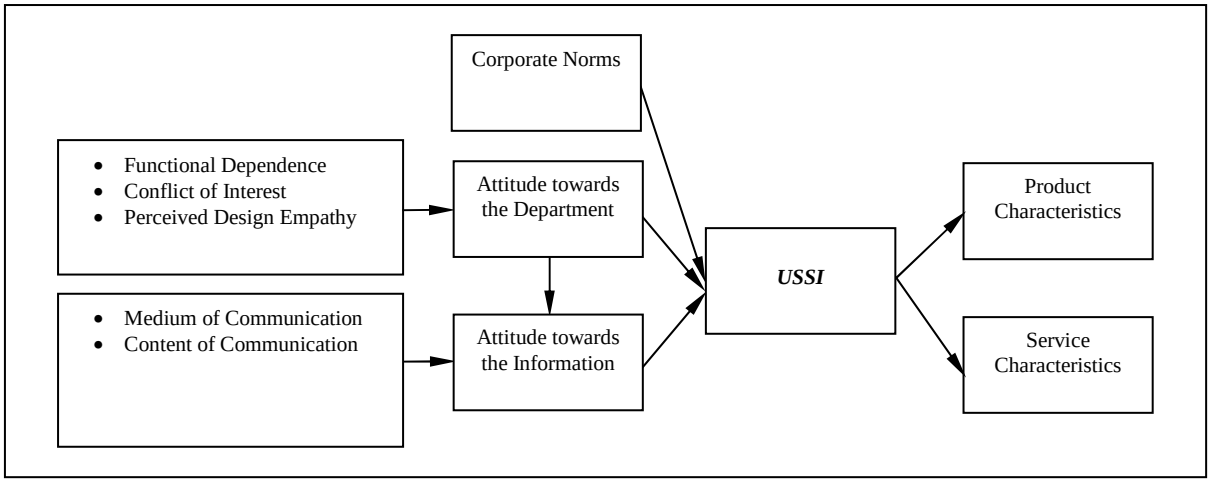
manufacturing. In each firm, a service manager and a design manager were interviewed separately. The design engineers were involved in day-to-day design activities and had managerial positions: one was a 'product design manager' and the three others were 'product design-team leaders'. These in-depth interviews gave us the opportunity to confirm the managerial importance of our research and illustrate our theoretical development with quotes from practice.

3.3.1. Focal Constructs: Antecedents and Outcome

Nakata and Sivakumar (1996, p. 62) characterize new product development (NPD) *as "the process of conceiving and creating a new product and the outcomes of that process."* Product design, which is defined as *"the activity that transforms a set of product requirements into a specification of the geometry and material properties of an artifact"* (Ulrich and Pearson, 1998, p. 352), is part of the broader product development activity. The term "design" therefore can refer to both engineering and industrial design which *"seeks to rectify the omissions of engineering; [it is] a conscious attempt to bring form and visual order to engineering hardware where the technology does not of itself provide these features"* (Moody, 1984, p. 62).

Our focal construct, i.e. the USSI, stems from research carried out by Maltz and Kohli (1996) on market intelligence dissemination across functional boundaries. Several researchers have demonstrated the importance of cross-functional information integration and its consequences on product development success and product quality. As a measure of service integration in design activities, we study the extent to which service-sourced information leads to concrete actions in designing new products. Figure 2 presents the antecedents to, and consequences of, our focal construct. We guide the reader through the model in the sections below.

Figure 2: Antecedents and Consequences of the *USSI* by Design Engineering



3.3.1.1. USSI and Design Engineers' Attitudes

Interest in service within manufacturing organizations is relatively new. It emerged when Bowen et al. (1989) called for research into customer service orientations among manufacturing companies that would compare the characteristics of service and manufacturing firms. However, service orientation has only recently been embraced at the team and corporate levels in the banking (Lytle et al., 1998) and retailing sectors (Homburg et al., 2002). At the individual level, it has been tackled by Cran (1994), Hurley (1998), and Keillor et al. (1999). A service orientation, which has been formally defined as *"an organization-wide embracement of a basic set of relatively enduring organizational policies, practices, and procedures intended to support and reward service-giving behaviors that create and deliver service excellence"* (Lytle et al., 1998, p. 459), can be studied at various levels; our interest in the concept pertains to the practices implemented by manufacturers during the design stage of NPD.

The consumption of service-sourced information (consumption behavior) will be a consequence of the attitude that the DED has toward the information it receives from the support service department. Attitudes are defined as *"a categorization of a stimulus along*

an evaluative dimension, based on cognitive, affective, and behavioral information" (Fiske and Taylor, 1991; p. 463). According to the theory of reasoned action, the stronger the positive attitude with respect to a behavior, the stronger the individual's intention will be to perform that behavior (e.g., Fishbein and Ajzen, 1975). In turn, that attitude toward the information received is composed of two dimensions: the behavioral intention to use the information, also called the conative dimension (Leyens and Yzerbyt, 1997), and the cognitive evaluation of the information, which is formed by its perceived comprehensibility or clarity, relevance, accuracy, and timeliness (Maltz and Kohli, 1996). Following the guidelines of the theory of reasoned action, we hypothesize:

H1: The stronger the positive attitude of the design-engineering department toward information received from the support service department, the higher the USSI will be.

Furthermore, we argue that the DED's attitude toward the support service department will directly influence its information consumption behavior. Frequently, research has investigated how members of functional areas perceive one another in terms of experience similarity (Moenaert and Souder, 1990), rivalry (Maltz and Kohli, 1996), functional goals, and norm congruence (Kahn, 1996). At a higher level, through the experience of working together and word of mouth within the firm, individuals from one functional area develop attitudes—on top of their stereotypes (Alexander et al., 1999)—toward their colleagues' departments. To evaluate attitudes toward other departments during a working relationship, we consider the employees' cognitive and affective evaluations of the general working relationship (adapted from De Jong et al., 2004; Ruekert and Walker, 1987) and their behavioral intention to work together (Leyens and Yzerbyt, 1997). We formulate:

H2: The stronger the positive attitude of the design-engineering department toward the support service department, the higher the USSI will be.

Also, we posit causality between the attitude toward the functional area and the attitude toward the information received from that functional area. If one functional area has developed a positive attitude toward another, it will positively influence the perception of the information transmitted from the latter. Along the same lines, Sussman and Siegal (2003) have demonstrated a significant relationship between a source's credibility and the perceived usefulness of its message. In addition, Moenaert and Souder (1996) show that the relationship between the source and the receiver influence information credibility and comprehensibility. Therefore:

H3: The stronger the positive attitude of the design-engineering department toward the support service department, the stronger the positive attitude toward the received information will be.

Inspired by Fishbein's (1980) work on subjective norms, we posit that 'corporate norms' will also play a role in the extent of USSI practices. Corporate norms is defined as the DED's perception of the degree to which they should use service-sourced information in their design work. Top management imperatives and peer pressure lead design engineers to engage in USSI practices. Indeed, the referents' beliefs integrates one’s own beliefs; the opinion of a large group of people cannot be wrong (Venkatesh and Davis, 2000). The direct role of top management practices and strategies in NPD has been demonstrated extensively in literature as a significant influence on new product success (Souder and Jenssen, 1999), intraorganizational technology diffusion (Pae et al., 2002), and the degree of and need for organizational integration (Millson and Wilemon, 2002). This influence is what Millson and Wilemon (2002) identify as the link between management philosophy

and the degree of organization integration. We suggest that top management's well-founded strategic role can be extended at the operational level. More than exclusively defining strategies, we point forward that top management should convey the feel of truly paying attention to the cognitive processes involved in the DED's job tasks (Levy, 2005); hence establishing compelling corporate norms triggering design engineers to the USSI. For these reasons, at the functional level and based on the theory of reasoned action, we argue that:

H4: Corporate norms (those dictated by management philosophy and peers) relate positively to the design-engineering department's USSI.

3.3.1.2. Antecedents to Attitudes toward the Department and Information Received

On the basis of a literature review and our in-depth interviews, we identify (1) conflict of interest, (2) perceived design empathy, and (3) functional interdependence as antecedents to the attitude that the DED will develop toward the support service department.

We aim to demonstrate that the higher the perceived conflict of interests between the DED and the service department, the weaker the positive attitude will be toward the support service department. For instance, two service managers voiced similar concerns during the in-depth interviews: (1) "*Design people are quite reluctant to make changes to the product. They quite often say that our requirements are too complex or not adequate for production*"; (2) "*Sometimes engineers can't see how they can satisfy all the service issues. […] They really have to find the balance between changing product design and not creating extra complications.*"

Even if the support service department is unlikely to actively engage in a rival relationship with the DED – i.e., perceiving each other as competitors (Maltz and Kohli, 1996) –, the design and service delivery of products may create conflicts of interests. For

example, to service or repair a photocopier, the service engineer may have to spend more time to dismantle the product than s/he wishes because the designers did not take this factor into consideration when they designed the copier. Alternatively, they may have taken this issue into account, but cost efficiency, economies of scale, or other production imperatives may have led to a design that ignored service flexibility considerations. This means that the DED and the service department may have to actively negotiate (Butler, 1999) to create a win-win situation in terms of product design for serviceability. We posit that interfunctional conflicts of interests will negatively influence design engineers' attitude toward the service department.

H5: The higher the perceived conflict of interest by the design-engineering department, the weaker its positive attitude toward the support service department will be.

A second antecedent to attitude formation is defined as perceived design empathy, i.e., the perception held by the DED about service people's understanding of their product design activities. Literature already has tackled the issues of trust in team members (Madhavan and Grover, 1998) and in the information sender (Maltz and Kohli, 1996). Atuahene-Gima and Evangelista (2000) have demonstrated a significant positive relationship between perceived expert power and a department's influence in new product performance.

However, the approach we take does not refer to the perceived expert power of the support service department in terms of service activities but rather the perception held by the DED about service people's understanding of their product design activities. A functional area can be perceived as being very good at its job, but that perception does not necessarily mean that others will develop a positive attitude toward that department. A positive attitude develops only when other departments trust it to understand their own reality, which will make it a profitable interlocutor.

Three design managers referred to this perceived design empathy explicitly. (1) "*Because we receive quite a lot of information from the service department […], we need to make sure that they send us relevant stuff. They need to know what we really need*"; (2) "*Sometimes we get the feeling that the service people are a little late with the info. Because they don't quite know what we're doing right now, some of the information is not really important to us,*" (3) "*This is our reality! That's what we want to say to the service engineers when we ask them for information on how the products are doing in the market in terms of design, which is what we're talking about."*

H6: The higher the perceived design empathy of the support service department by the design-engineering department, the stronger its positive attitude toward the support service department will be.

Moreover, literature and interviews signify the importance of functional dependence (Fisher et al., 1997; Ruekert and Walker, 1987). To achieve its goals and responsibilities, the DED may need resources, outputs, and support from the service department. Because product design influences service capabilities and effectiveness (Goffin, 2000; Lele, 1986), we expect that design engineers will need input and resources from the support service department. At the very least, they need to communicate during the servicing of the products following their market launch. Drawing on the theory of cognitive dissonance (Festinger, 1957) and attitude ambivalence, we suggest that if design engineers know that they have a high dependency on support service employees, they will tend to develop a more positive attitude toward the support service functional area. This tendency reflects the need to eradicate disharmony and reach consistency between the recognition of dependence and the general attitude toward the functional area (Priester and Petty, 1996). Therefore, we posit:

H7: The higher the perceived dependence on the support service department by the design-engineering department, the stronger its positive attitude toward the service department will be.

Communication channels

People exchange information through three different channels of communication: written, verbal, and electronic (Maltz and Kohli, 1996; Moenaert and Souder, 1996). Two theories explain the relationship between the characteristics of a communication channel and the communication activity: social presence and media richness (Rice, 1993; Westmyer et al., 1998). The social presence theory refers to the presence (or absence) of social cues during communication, such as facial expressions, vocal cues, and posture. According to this theory, verbal communication is more personal and creates greater psychological proximity (Pratt et al., 2000) than either written or electronic communication. According to the media richness theory, the more cues and senses are involved, the greater the possibility of immediate feedback. Furthermore, the more the relationship is of a personal nature, the richer the media will be (Westmyer et al., 1998). Using both theories of communication, we classify our channels from the highest social presence and media richness to the lowest, as follows: verbal face-to-face communication, telephone conversations, written information, and electronic mail and online databases (Suh, 1999).

In all cases, functional areas need accurate, relevant, clear, and timely information. However, even though face-to-face verbal communication earns the highest social presence and media richness rankings, it may not be the most preferred communication channel for receiving information. The DED and support service employees may have different preferences according to their personal traits and job characteristics. Design engineers are known to have a low tolerance for ambiguity and a more scientific professional orientation, which enables them to set design priorities, just like R&D

engineers (Griffin and Hauser, 1996). Therefore, we postulate that design engineers will favor written over verbal information during communications with the support service department. We posit that the frequency of written information will positively influence the attitude toward the information, whereas verbal communication will have a negative relationship. Literature has shown that verbal communication within the DED is very important for problem solving (Tushman, 1979). Therefore, we infer that design engineers are less open to further verbal interactions with the service functional unit. Our field site observations corroborate this. The support service department generally contacted the DED as part of their customer problem-solving escalation procedures. However, the high frequency of verbal communication needed to solve customer problems on demand distracts design engineers from their activities. But also – aside from communication during escalation procedures – we posit that designers develop negative attitudes toward verbal interactions with field service employees as a consequence off the 'communication sphere' during these interactions. Of all corporate departments, R&D and product design engineers "*seems to have the edge in using obfuscatory jargon*" (Sebell, 1994, p.2). Therefore, functional jargon most probably contributes to creating an apprehensive communication sphere when employees of both departments verbally interact to discuss design for serviceability. Hence, we formulate two related hypotheses:

H8 (a): The higher the frequency of receiving written information, the stronger the positive attitude toward the information will be.

H8 (b): The higher the frequency of receiving verbal information, the lower the positive attitude toward the information will be.

Regarding electronic mail and online databases, we posit an inverted U-shaped relationship between the frequency of electronic communication and attitude toward the information.

Electronic mail, for most task types, has *marginal* or *poor fit* due to information constraints (Belanger, 1999; Suh, 1999). This should especially be the case for product design activities, which are intellectual and judgmental (Suh, 1999). It is thus the specificity of the design task, which leads us to postulate that the invert U-shaped relationship will exclusively be present when information is exchanged electronically. Indeed, according to media synchronicity theory (Dennis and Valacich, 1999), electronic information has limited value when members need to agree on the meaning of information and the course of action that needs to be taken (Dennis, Wixom, and Vandenberg, 2001). Therefore, we posit that design engineers can appreciate the value of electronic information but will also be sensitive to e-information overload for a task that requires – *in fine* – precise and intellectual information, which can more easily be conveyed via other communication media.

Our approach is a little different for database consultation given that one usually chooses to consult a database. Because it is the only communication medium that the receiver can choose to consult, without it being imposed on him or her, we specified that the consultation of the database be electronically imposed to them in order to access information. Fundamentally, there is no reason to believe that receiving e-mails is different than requests from the support service employees to consult databases to access electronic information. In both cases, design engineers can choose to consult or discard the electronic information easily without having to physically throw away written documents or ignore the content of verbal communications with their colleagues. Hence:

H8 (c): The relationship between the frequency of receiving electronic information and the attitude toward the information will follow an inverted U-shaped function.

Communication content

Information sent from the service department to the DED touches on three main content domains: the product performance, product aesthetics (i.e., the appearance and appeal), and product ergonomics (i.e., safety, ease of use, comfort) of the product (Bloch, 1995; Johnston and Gibbons, 1975; Mathieu, 2001; Oliva and Kallenberg, 2003; Srinivasan et al.,1997). A taxonomic synthesis is provided in Appendix IV.

Design employees will value some of the field feedback information received from the service department, because it may give them new research ideas and/or help them develop future generations of the same product. Troy et al. (2001) find a positive correlation between the amount of market information and the number of new product ideas. Our field site interviews suggest that design engineers especially value field feedback information regarding the performance of the product. That information involves technical, factual, and measurable details, to which design engineers can easily relate. In similar vein, design engineers appreciate information about product ergonomics, because it is information regarding the practical installation and ease of use of the product, and such information indicates how the product is experienced in practice. As for aesthetics, some designers found such information to be of a more peripheral nature and less relevant compared with that on performance and ergonomics. Some even felt that such information offended to their creativity: "*For many of us, working on product aesthetics is the opportunity to express ourselves! I don't expect service people to tell us anything about good design…*"

H9 (a): The higher the frequency of receiving information about product performance and product ergonomics, the higher the design-engineering department's positive attitude toward the information will be.

H9 (b): The higher the frequency of receiving information about product aesthetics, the less positive the attitude of the design-engineering department toward the information will be.

3.3.1.3. Outcomes of Service for Design Practices

In reference to the work of others regarding the consequences of information utilization, we posit that design engineers can significantly increase the market performance of new products in terms of product characteristics by consuming service feedback information (Atuahene-Gima and Evangelista, 2000; Kahn, 2001; Menon et al., 1997; Millson and Wilemon, 2002). In addition, we postulate that service responsiveness and reliability (Parasuraman et al., 1988) will be higher when product designers take serviceability into greater account. Not only do design engineers better understand the needs and requirements of the market for their industrial and engineering product designs if they are involved in USSI, but service employees also will feel part of the design process and, therefore, value product improvements when they service them. Consequently, the responsiveness and reliability of support services delivery may increase. Using work by Souder and Jenssen (1999), we define product characteristics as formed by relative product quality (Grönroos, 1998) (including aesthetics and ergonomics); performance, technical, and mechanical features; and reliability. As for service characteristics, we include service reliability and responsiveness from the five dimensions identified by Zeithaml et al. (1990). The reason for focusing on these dimensions of service quality is that they are the only ones which can directly be affected by the USSI in product design activities Hence:

H 10 (a): The higher the USSI by the design-engineering department, the better product characteristics will be.

H 10 (b): The higher the USSI by the design-engineering department, the better service responsiveness and reliability will be.

3.4. Research Method

3.4.1. Data Collection

We collected the data for this study from U.S. manufacturing companies. The responding design engineers held managerial positions in their company's DED and were directly involved in day-to-day design activities. The 350 design-engineers with managerial positions purchased from a business mailing list were mailed a survey questionnaire and a return postage-paid envelope. Managers were also offered the opportunity to complete the survey online.

We additionally telephoned each potential respondent to inform him or her that s/he would be receiving a paper survey, which we had just sent, and to make sure they were involved in product design activities. If we could not converse with the managers directly after two attempts, we left a short message on their voicemail. Of the 350 managers contacted, 15 had left the company or changed functions and not been replaced. Therefore, our total sample of potential recipients was 335 design managers. The combination of the paper survey, the option of online completion, and the telephone conversation resulted in 144 returns, of which 121 were usable (49 via regular mail, 72 online). We note that the frequency of electronic and written communication do not significantly differ based on whether the data was collected via the paper survey or the electronic survey (*F electronic*: 0.329 – *p*: 0.567; *F written*: 0.891 – *p*: 0.347). Also, the support for USSI did not significantly differ between the latter groups (*F*: 0.755; *p*: 0.387). Out of the 121 design-engineering managers (34.6% response rate), 54 are senior design managers, 49 middle design managers, and 18 junior design managers. With regard to the industries – based on the classification of the *Financial Times* – 5% of the companies belonged to the transportation industry, 18% to computer manufacturing, 39% to electronic manufacturing,

30% to manufacturing of machinery and equipment for the industry, and 8% to the telecommunication industry.

3.4.2. Psychometric Properties of the Measurement

We present the scales for this study in appendix IV. All measures are adapted from existing scales, as referenced in the appendix. The scales employed to measure conflict of interest, perceived design empathy, information content, corporate norms, attitude toward the department, USSI, and functional interdependence are all reflective. The domain of these constructs is unique and reflected by several items that are interchangeable and expected to vary with one another. Dropping an item does not alter the domain of the construct (Jarvis et al., 2003).

We operationalized the other constructs using formative measures. Indeed, their domain is formed of several sub-domains and dropping an indicator would alter their domain. Thus, the frequency of communication is represented by separate dimensions that compose the written, verbal, and electronic communication media (e.g. Dawes and Massey, 2001; Fisher et al., 1997; Maltz and Kohli, 1996). The attitude toward the information is measured using a composite scale function of information clarity, relevance, timeliness, and accuracy (Maltz and Kohli, 1996), as well as of the behavioral intention to use it (Leyens and Yzerbyt, 1997). The same is valid for product and service characteristics, which are evaluated according to several aspects that form an overall perception.

We used PLS-Graph Version 3.0 (Chin, 2001) to obtain partial least squares (PLS) estimates for both the measurement and structural parameters in our structural equation model (SEM) (Chin, 1998; Hulland, 1999). A component-based SEM approach, PLS path modeling does not require multivariate normal data, places minimum requirements on measurement levels, and is more suitable for small samples (Chin, 1998; Fornell and

Bookstein, 1982). Moreover, PLS can more easily accommodate the use of formative indicators than can covariance-based SEM (Chin, 1998; Hulland, 1999). To ensure our sample size was adequate for the analysis, we conducted a power test, as proposed by Cohen (1988) for the *F*-test, using R^2 for the endogenous constructs. Assuming a medium effect size ($f^2 = 0.15$; $R^2 = 0.13$) for the nine predictors, a significance level (α) of 0.05 and a desired power ($1 - \beta$) of 0.80 in our analysis requires a sample size of 113. Green's (1991) approach yields a required sample size of 115. Both figures show that we have sufficient power to estimate our model in PLS.

In addition, PLS path modeling enables us to assess the psychometric properties of the measurement instruments: reliability, convergent validity, and discriminant validity (Chin, 1998; Fornell and Larcker, 1981). To assess the psychometric properties of the measures, we tested a measurement model without structural paths in PLS-Graph Version 3.0 (Chin, 2001), which is analogous to confirmatory factor analysis in covariance-based SEM. Convergent validity can be evaluated by inspecting the factor loadings of the measures on their respective constructs (Chin 1998; Tenenhaus et al., 2005). Every item should have a standardized loading that exceeds 0.5. The purification of the measures led us to drop two items from the conflict of interest and verbal communication measures because of, respectively, a loading issue and the complete absence of use (i.e., no one used videoconferencing). We assessed reliability with composite reliability and average variance extracted (AVE) (Chin, 1998) (see Table 1 of the appendix). Composite scale reliability ranged between 0.852 and 0.957, well in excess of the cut-off value of 0.7 suggested by Nunally and Bernstein (1994). The AVE ranged between 0.538 and 0.917 and thus exceeded the 0.5 cut-off value proposed by Fornell and Larcker (1981). Finally, we assessed discriminant validity by examining whether each construct shared more variance with its measures than with other constructs in the model (Barclay et al., 1995;

Chin, 1998). Therefore, the square root of the AVE should exceed the construct intercorrelations in the model. As we show in Table 5, construct intercorrelations in the model do not exceed the square root of the AVE for the constructs (Fornell and Larcker, 1981). Finally, since our data were collected using a survey questionnaire, we verify for common method variance (CMV). Lindell and Brandt (2000) and Lindell and Whitney (2001) posit that the smallest correlation with a theoretically unrelated variable is a judicious estimate of common method variance. Then, for all bivariate correlations the effect of the smallest correlation (r_s) needs to be partialled out in order to remove the effect of CMV. However, our survey questionnaire did not contain such a theoretically unrelated construct. Therefore, we took a slightly different approach by selecting the smallest correlation among our theoretical variables. This is the correlation between the 'attitude toward the information' and the 'frequency of receiving electronic information' (r_s = .006). From our application of the procedure, we conclude that for all significant effects of the antecedents on USSI and the consequences on USSI, the corresponding bivariate correlation coefficients remain statistically significant at $p < .05$ after adjusting for CMV. Therefore, we may conclude that the effects due to CMV are negligible in our study.

3.5. Analysis and Results

To test the effects and statistical significance of the parameters in the structural model, we used a bootstrapping procedure with 250 resamples with individual sign preprocessing (Chin, 1998, 2001; Efron and Tibshirani, 1993). We present our descriptive findings in Table 5, which provides the means, standard deviations, and correlation matrix for the constructs that we explored. We also tested for industry effects on the extent of support for USSI but found no significant differences across industries.

3.5.1. Antecedents of USSI

Hypothesis 1, which states that a stronger positive attitude toward the information received from support service engineers would induce greater information consumption behavior by design engineers, is supported ($\beta = 0.224$, $p < 0.05$). We also postulated that the attitude toward the department influences the USSI (Hypotheses 2-3). Both hypotheses are supported: the analysis shows a significant positive relationship between the attitude toward the support service department and the use of information to design new products ($\beta = 0.218$, $p < 0.01$) and significant positive relationship between the attitude toward the support service department and the attitude toward the information ($\beta = 0.636$, $p < 0.01$). These findings demonstrate the crucial role of attitude toward the service department, which not only has a direct impact on USSI but also mediates the attitude toward the information. Finally, hypothesis 4 is also supported by the data: corporate norms fostering USSI have a significant positive impact on USSI ($\beta = 0.357$, $p < 0.01$). These antecedents explain 42.1% of the variance for USSI practices. In particular, we show that the strongest predictors of USSI are the formalization of rules and procedures by management (0.357) and the direct (0.218) and indirect (0.142) effects of attitude toward the support service department.

Table 5: Descriptive and Correlation Matrix [a]

	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	16
1. Attitude toward department	3.91	0.61	***0.78***														
2. Perceived design empathy	3.15	0.78	.434	***0.82***													
3. Conflict of interest	2.45	0.71	-.455	-.401	***0.73***												
4. USSI	3.81	0.78	.504	.245	-.250	***0.85***											
5. Corporate norms	3.86	0.91	.375	.128	-.084	.539	***0.95***										
6. Functional dependence	3.54	1.10	.412	.367	-.236	.431	.231	***0.89***									
7. Written info. frequency	1.99	0.92	.300	.335	-.197	.283	.075	.443	N/A								
8. Verbal info. frequency	2.07	0.78	.219	.361	-.291	.271	.170	.393	.399	N/A							
9. Elect. info. frequency	2.77	1.21	.129	-.025	.013	.111	.148	.145	.109	.137	N/A						
10. Performance information	1.74	0.71	.351	.386	-.218	.225	.223	.354	.462	.362	.027	***0.77***					
11. Aesthetics information	1.57	0.76	.205	.287	-.081	.236	.176	.276	.404	.407	.045	.446	***0.89***				
12. Ergonomics information	1.78	0.89	.201	.306	-.121	.224	.170	.390	.237	.395	.097	.489	.552	***0.87***			
13. Product characteristics	3.92	0.67	.303	.323	-.287	.361	.161	.112	.335	.222	-.04	.207	.097	.038	N/A		
14. Service characteristics	3.98	0.81	.336	.298	-.345	.264	.149	.139	.063	.187	.075	.238	.101	.096	.577	N/A	
15. Attitude toward information	3.45	0.74	.680	.417	-.411	.534	.453	.398	.361	.298	-.006	.368	.161	.258	.333	.286	N/A

[a] Square root of AVE on diagonal. 'N/A' is indicated for formative constructs.

3.5.2. Antecedents of Attitude toward the Department

The next three hypotheses identify predicting variables of the attitude toward the support service department. Hypothesis 5, postulating a negative influence of conflict of interest, is supported (β = -0.307, $p < 0.01$). Also hypotheses 6 and 7, which posit positive impacts of PDE and functional dependence on the attitude toward the functional area, are both supported (β = 0.215, $p < 0.01$; β = 0.261, $p < 0.01$, respectively). These findings communicate important information to manufacturing companies regarding issues such as transparency, as well as the cultural valuation of collaboration and interest in other areas' work. The value and relevance of these findings are significant; conflict of interest, PDE, and functional dependence together explain 34% of the variance of the attitude toward the department.

3.5.3. Antecedents of Attitude toward the Information

Furthermore, we tested hypotheses that attempt to explain the way in which an attitude toward information develops. We tested the impact of the medium of communication on the perceived quality of the information. Hypothesis 8a, suggesting a positive relationship between the frequency of receiving written information and a positive attitude toward the information, is supported (β = 0.179, $p < 0.01$).

Hypothesis 8b, on the contrary, is not supported by the data (β = 0.119, $p > 0.05$). Apparently, a higher frequency of receiving information verbally does not lead to a more negative attitude toward the information.

Our third hypothesis regarding the medium of communication posited an inverted U-shaped relationship for electronic communication and attitude toward the information. Since we used a formative measure for electronic communication, we calculated the quadratic term on the basis of the latent variable scores for the frequency of electronic

communication (cf. Chin et al., 2003). Our results demonstrate a significant inverted U-shaped relationship (main effect: $\beta = 0.07$, $p > 0.05$; quadratic effect: $\beta = -0.147$, $p < 0.05$), supporting hypothesis 8c. We confirm that this finding applies only to electronic information exchanges by revealing no curvilinear relationship (inverted U-shaped) between the frequency of written ($t = -0.289$; $p = .77$) or verbal ($t = -0.868$; $p = .39$) communication and the attitude toward the information.

Hypothesis 9a is partly supported. Design engineers appreciate feedback about product ergonomics ($\beta = 0.201$, $p < 0.05$), but are indifferent to feedback about product performance ($\beta = -0.104$, $p > 0.05$). As for information about ergonomics, the relationship is significant, which demonstrates that design engineers appreciate information regarding product installation, safety, and ease of use. This finding might be explained since obtaining feedback on these issues reflects the success of the user's experience with the product and therefore is an indication of how the product is experienced in the market. Hypothesis 9b is confirmed ($\beta = -0.171$, $p < 0.05$). As suggested during our in-depth interviews, design engineers do not appreciate receiving market feedback about product aesthetics (size, color, shape, and so forth). The predictors for attitude toward the information explain 54.1% of the constructs' variance. Clearly then, our study includes key predictors that can help manufacturers understand why design engineers perceive information positively or negatively. In Table 6, we summarize these results.

Table 6 Summary of Findings

Hypotheses	**β**
Focal constructs	
H1: Attitude toward Information → USSI	**0.224***
H2: Attitude toward Department → USSI	**0.218****
H3: Attitude toward Department → Attitude toward Information	**0.636****
H4: Corporate Norms → USSI	**0.357****
(Service for Design: R^2 = 0.422)	
Antecedents to Attitude toward Department	
H5: Conflict of Interest → Attitude toward Department	**- 0.307****
H6: Perceived Design Empathy → Attitude toward Department	**0.215****
H7: Functional Dependence → Attitude toward Department	**0.261****
(Attitude toward Department: R^2 = 0.340)	
Antecedents to Attitude toward Information	
H8(a): Written Information Frequency → Attitude toward the Information	**0.179****
H8(b): Verbal Information Frequency → Attitude toward the Information	0.119
H8(c): Electronic Information Frequency → Attitude toward the Information	**-0.147****
H9(a)1: Product Performance information → Attitude toward the Information	Main effect: 0.07 -0.104
H9(a)2: Product Ergonomics information→ Attitude toward the Information	
H9(b): Product Aesthetics information → Attitude toward the Information	**0.201***
(Attitude toward Information: R^2 = 0.539)	**-0.179***
Consequences of Service for Design	
H10(a): Service for Design → Product Characteristics (PC)	
H10(b): Service for Design → Service Characteristics (SC)	
(PC: R^2 = 0.136; SC: R^2 = 0.07)	**0.369**** **0.263****

Notes:
Coefficients in bold are significant. (**p < 0.01; * p < 0.05)
Goodness of fit index = Sqrt (μ Communality * μ R-square) (Tenenhaus et al., 2005) = 0.429

3.5.4. The Outcomes of USSI

The final two hypotheses pertain to the impact of USSI. Does it profit the manufacturer to use support service feedback to design products? Does it affect product characteristics (hypothesis 10a) and service reliability and responsiveness (hypothesis 10b)? Both hypotheses 10a (β = 0.369, p < 0.01) and hypothesis 10b (β = 0.263, p < 0.01) are

supported: it clearly pays off for a manufacturer to integrate field service feedback into its design production!

3.5.5. Overall Model Fit

To conclude the structural analysis of the model, we calculated the goodness of fit (GoF) of the model. Recently, Tenenhaus et al. (2005) developed GoF ($0 \leq GoF \leq 1$) as a global fit measure for PLS and defined it as the geometric mean of the average communality. Because the communality equals the AVE in the PLS approach, we propose a cut-off value of 0.5 for communality (Fornell and Larcker, 1981). Moreover, in line with the effect sizes for R^2 (small 0.02, medium 0.13, large 0.26) proposed by Cohen (1988), we derive the following GoF criteria for small, medium, and large effect sizes of R^2: 0.1, 0.25, and 0.36. Our GoF index reaches 0.429. Therefore, we acknowledge this model fit to be good.

3.6. Managerial Implications

The empirical results compellingly demonstrate the importance of integration mechanisms between the service and design departments; two functions that have not been studied previously. From these findings, we derive important points of discussion and courses of action that should be taken by manufacturing companies.

3.6.1. Product Design and Managing Service Feedback

The present study shows that the service personnel must not be ignored in the innovation process. It is the very nature of their job, positioned as a membrane between the industrial company and its network of industrial customers that puts them in a unique position in the innovation communication network. While working for the supplier, they operate on a daily basis on the customers' premises, acquiring specific knowledge on customer

requirements, technological opportunities, and competitive offerings. Much of this working knowledge will be of a tacit nature (Baumard, 2002), i.e., difficult to codify. In order for the service/design feedback loop to operate proficiently, direct communication between the service and design functions is needed.

Our findings show there is more to it than simply increasing the communication frequency between service employees and designers. In order to effectively manage these relationships, manufacturers must (a) create an atmosphere for communication and (b) acknowledge that designer-profile specificities affect their perceptions and use of information transmitted to them. A healthy working relationship between the DED and the support service department contributes to innovation success. Unfortunately, the working relationship between these two functions often involves conflict (M= 2.45; as shown in Table 5). While the development of a healthy intergroup climate is rarely accomplished by means of a quick fix (Patterson et al., 2005), interfunctional socialization efforts may provide an organizational method to accomplish this. It fosters goal congruence and process transparency across functionally different subgroups in the innovation process (Harris and Mossholder, 1996).

Thus, our findings also lead to the following reflection point: Could extensive interfunctional communication start harming innovative success? In other words, how manageable – in terms of time and complexity – is cross-functional communication? This signifies that the absence of a significant relationship between the frequency of verbal communication and a positive attitude toward the information may be contingent to the overall amount of communication design engineers must engage in during the course of their design work. We cannot answer this question as such but can help manufacturers in reaching an effectively-managed design/service interface by discussing the role of top management and the most preferred communication medium and content.

3.6.2. Product Design and Top Management Involvement

Previous research has consistently demonstrated the pivotal role top management assumes in fostering productive interfaces between the R&D, marketing, and production functions (Atuahene-Gima and Evangelista, 2000). The present study shows that top management's role in motivating their workforce to co-operate must be extended (hypothesis 4). Top management can do this by emphasizing the role of service in the planning and development of new products. In addition, the effectiveness of this approach must be monitored using the right performance standards. More importantly however, they need to create a congruent culture of information sharing between design and service personnel. The behaviors, and genuine cognitive involvement, of top managers in DED's processes will provide important role models for their personnel (Rich, 1997). It is crucial to identify cultural differences and how they may affect the potential creation of a beneficial working relationship between service and design employees (DiBella, 1996). This leads to our third managerial implication. Based on the observation that product designers and R&D employees have similar profiles, we explain which medium of communication and what kind of information designers value.

3.6.3. Product Design and Communication Medium and Content

Our research shows that, as far as the design/service-interface is concerned, the communication medium is indeed partly the message. Frequent written communication helps getting the message across as designers value written information. Management must think of the right architecture and appropriate incentives to facilitate the dissemination and use of written information.

If field service engineers wish to communicate with design engineers by electronic means, we derive an optimum exchange of electronic information between service and

design people: once to three times a week (based on the quadratic function $Y = C + 0.07\ x - 0.147\ x^2$; see test of hypothesis 8c). We verified whether this finding applied to electronic communication only, and not to written and verbal communication, which suffer from fewer informational constraints (Suh, 1999). Our analyses revealed no curvilinear relationship (inverted U-shaped) between the frequency of written or verbal communication and the attitude toward the information.

Also, while design engineers in industrial firms tend to hold a negative attitude toward information about product aesthetics, customer-orientation is a condition sine qua non for successful product development (Bloch, 1995). Even in so-called functional B2B-settings, products must not only be functionally convincing but also sensory appealing. Manufacturers should therefore emphasize these facts to design engineers while establishing that service employees are not '*taking on their creativity job*'. Additionally, service engineers should make sure to communicate aesthetics detail using written communication, or eventually, electronic communication making sure that the frequency of total exchanges remains below three times a week. Regarding the absence of a significant association between the frequency of receiving information about product performance and a positive attitude toward the information, we speculate that design engineers may not be ready to take on such information from support service people. This could be due to the absence of performance-related design-jargon in service feedback and/or contingent to perceived design empathy.

3.7. Research Limitations

The first limitation pertains to the use of the key informant method (Philips, 1981), especially given that we measure attitude variables. The theory of reasoned action is usually refereed to at an individual level of analysis. Our study could have better measured

functional attitude by surveying each designer constituent of the department. This said such a study would have required a different research setting. Surveying all design engineers of a department could have been feasible assuming that the study was carried out in a limited number of departments. However, this would have introduced other limitations such as external validity and information boundaries in measuring other constructs in our conceptual model (i.e. corporate norms).

Second, our study was carried out in manufacturing companies, which had their own service department. However, the number of manufacturers outsourcing or acquiring service unit is on the rise – i.e. the IBM–PwC $3.5 billion deal made in 2002. This could mean that our results have limited value for such companies given that we did not evaluate the effects of corporate governance/organizational design on our findings. Factors such as 'outsourcee commitment' and 'corporate culture' could influence the attitude of design engineers towards service employees bounded to a different company.

Also, identically than observed in chapter two, it is possible that designers' perceptions of product and service characteristics differ from those of customers. Indeed, past research demonstrated that such differences may exist between employees and customers regarding the interpretation of field feedback information (Petkova, 2003).

Finally, we did not examine the role of moderating variables such as market volatility, which may affect the relationship between USSI and positive perceptions of product and service characteristics. Past studies have found a moderating role of market volatility on the reachability of firm performance (Pine, 1993). In markets with fast-changing customer demands, the integration of field service feedback by design engineers may have lower positive returns on product and service performance. Future research could investigate contingent effects on the linkages between antecedents and consequences of the USSI.

Chapter 4

Knowledge Diffusion and its Impact on On-Going Product Design Decisions: A Social Network Analysis

4.1. Abstract

Product decision-making is critical for manufacturing organizations since many new products fail once in the market (Cooper, 2001). This chapter aims at helping manufacturing firms increase the probability of product success. First, we identify go/no-go decision criteria taken into consideration when making on-going product design decisions (PDD). Second, we demonstrate that functional membership has a significant influence on the concern/support for go/no-go decision criteria. Lastly, we show that functional membership and communication network positions – i.e. employee degree centrality – influence PDD outcomes. Ultimately, our findings enable us to formulate guidelines in order to reduce PDD bias and therefore increase the probability of new product success.

4.2. Introduction

Product design and the physical building of the product determine a large majority of manufacturing costs (Bloch, 1995; Miller, 1988). Therefore, on-going product design decisions, which refer to the extent to which employees are willing to adapt, refine, or enhance the design of a commercialized product (Song and Montoya-Weiss, 1998), is a critical issue for manufacturing companies. In reality though, many products, which have gone through the new product development process, fail once in the market (Carbonell, Rodriguez, and Munuera, 2004; Cooper, 2001). Therefore, better decision-making during each stage of the product development process can significantly enhance new product success (Balachandra, 1984).

In order to reduce eventual decision-making biases, our exploratory study aims at identifying *(a) which criteria are taken into account during on-going product design decisions (PDD), and (b) how individual factors influence the support for these criteria, as well as, ultimately, on-going product design decisions.*

First, we investigate which go/no-go decision criteria are considered in order to make on-going PDD (Carbonell, Rodriguez, and Munuera, 2004) and whether the support for these criteria varies across individuals involved in the decision-making process across different departments.

Second, patterns of communication have been shown to influence the formation of marketing strategy and organizational buying behavior (Hutt, Reingen, and Ronchetto, 1989). Given that decision-making is based on information sharing, we argue that communication patterns between employees, and with customers, will similarly influence PDD (Slater and Narver, 1995). Using social network analysis, we explore the influence of communication networks on PDD. Several researchers have put forward that "*informal contacts often substitutes for formal new product processes*" (Griffin and Hauser, 1996, p.

205). Overall, our findings will be a first step towards clarifying and formalizing on-going product design decision-making, which can be relatively obscure (Englund and Graham, 1999).

Ultimately, our study puts back into the spotlight the importance of network studies for new product development (NPD) research. The most recent breakthrough of this methodology in marketing science dates back from the late 1980s (e.g. Hutt, Reingen, and Ronchetto, 1988) and was tentatively revived in the late 1990s by Achrol (1997). We demonstrate that studying new product decision-making as knowledge management (Madhavan and Grover, 1998) using sociological literature as previously suggested is relevant to unravel underlying NPD processes.

4.3. Research Background

4.3.1. New Product Decision-Making

NPD is a complex and uncertain process, involving various functional areas exchanging information in order to work their way through several successive stages to bring a product to the market (Buyukozkan and Feyzioglu, 2004; Song and Montoya-Weiss, 1998). Our first interest lies in shedding light on the decision-making criteria manufacturing companies consider when deciding on whether or not to work their way through NPD stages. While two recent exploratory studies exist (Carbonell, Escudero, and Munuera, 2004; Zahay, Griffin, and Fredericks, 2004), these aim at identifying decision criteria considered at each stage of the NPD process. Our study, however, contributes to literature by estimating whether, and the extent to which, concerns for go/no-go decision criteria differ between departments for a single stage of NPD. This could explain why, and help prevent, products from failing once in the market.

4.3.1.1. Stages of New Product Development

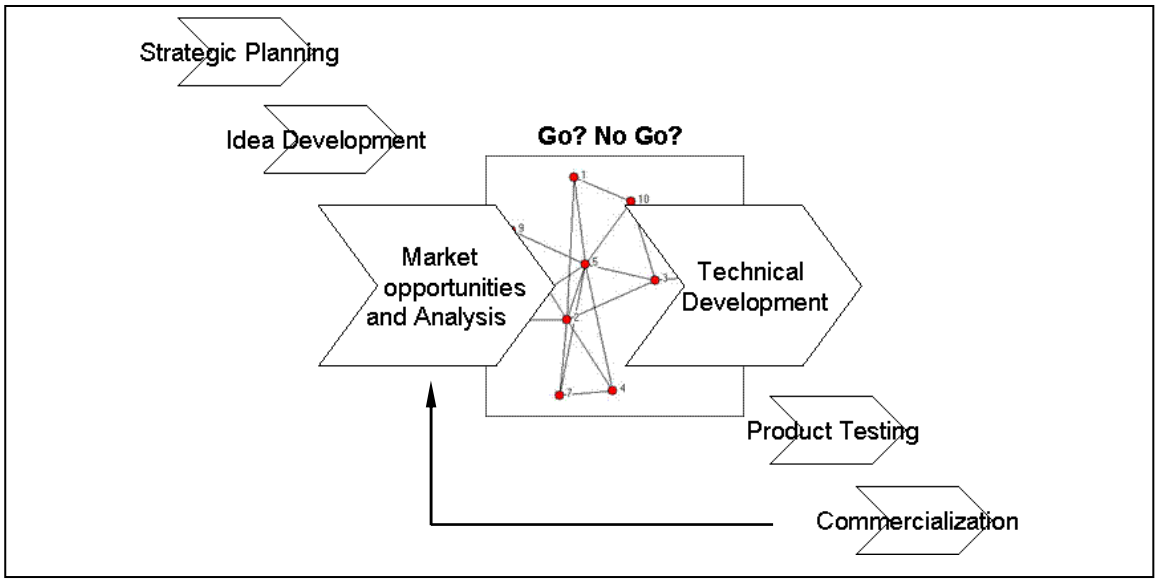
Based on extensive case studies, focus-group interviews, and a thorough literature study, Song and Montoya-Weiss (1998) identify six stages in NPD: strategic planning, idea generation, market opportunities and analysis, technical development, product testing, and commercialization (Figure 3). In the third stage, product features and attributes, as well as development feasibility, are identified based on market trends, competitor products, and customer needs (Perks, Cooper, and Jones, 2005; Song and Montoya-Weiss, 1998). The fourth phase of NPD relates more specifically to the design, engineering, and building of the desired physical product entity. Product design can refer to both engineering and industrial design, which is "*a conscious attempt to bring form and visual order to engineering hardware where the technology does not of itself provide these features*" (Moody, 1984 p. 62).

We investigate decision-making between these two stages of NPD for three reasons. First, because product design is critical for industrial products and determines the large majority of manufacturing costs (Bloch, 1995). Second, because findings relating to go/no-go decision criteria for these specific stages of NPD differ in both previously mentioned studies. The first demonstrates the significant role of 'technical' and 'customer-related' go/no-go decision criteria. Technical reasons refer to "*the availability of resources, the leverage of the firm's technical resources, and the project's total cost for a given cycle time*" (p. 94). Customer-related reasons refer to "*the customer satisfaction, product quality, and market acceptance*" (Carbonell et al., 2004, p. 94). The second study highlights customer information, project management information (for companies with project teams), and technical information – however, excluding financial aspects (Zahay et al., 2004) – as go/no-go decision criteria. Third, because it is between these two stages of NPD that go/no-go criteria least explain the variance of the dependent measure in previous

studies – i.e., product success in the market (Carbonell et al., 2004). Therefore, we formulate the following research question:

- RQ 6: Which go/no-go decision criteria are evaluated by manufacturing firms during on-going product design decisions?

Figure 3: Social network analysis between the third and fourth stage of incremental NPD



4.3.2. The Influence of Functional Membership on Decision-Making

Professional culture can influence interpretations and strategies for actions regarding environmental issues (Howard-Grenville, 2006), as well as the possession of specific types of functional knowledge (Sackmann, 1992). Within the innovation field, the differences in professional culture (caused by differences in personality, profiles, and the nature of the task) between the R&D and marketing departments has been acknowledged (Griffin and Hauser, 1996). With additional research indicating differences between employee profiles (Ruekert and Walker, 1987), we posit that the perceived importance of go/no-go decision criteria, as well as PDD, will significantly differ between employees of different departments. Past research suggests that functional experience is influential in shaping

belief structures, which can lead to differences in decision-making (Bowman and Daniels, 1995). This could be the case for PDD given that it integrates a complex set of activities that are as diversified as responding to customer demands on product aesthetics (color, shape, etc.) to the product engineering of highly complex components (Bloch, 1995). Based on the nature of go/no-go decision criteria identified in previous studies, we foresee that functional membership – due to the presence of different professional cultures – will affect the evaluation of go/no-go decision criteria, which will be established from answering our first research question. Therefore, we formulate the following research questions:

- RQ 7(a): To what extent does functional membership influence the concern for go/no-go decision criteria manufacturing firms use to make on-going product design decisions?
- RQ 7(b): To what extent does functional membership influence on-going product design decisions?

4.3.3. The Influence of Communication Networks on Decision-Making

We posit that informal patterns of communication influence PDD. The reality behind information acquisition in the 'market opportunity and analysis' stage of NPD and information dissemination can reveal interesting findings on the communication patterns between employees, which are neither explained by NPD theory nor by Jaworski and Kohli (1993)'s approach to market orientation. Market orientation is defined as information generation, dissemination, and use (Jaworski and Kohli, 1993). As stated by Maltz and Kohli (1996, p.48), "*market intelligence dissemination across functions represents an integral component of market orientation, which is a major concern of businesses today*" (p. 48). Market intelligence use can be improved by "*designing appropriate dissemination processes*" (op. cit. p. 48). In fact, effectively managed market intelligence from customers

and competitors create value by helping companies develop successful new products (Brown and Eisenhardt, 1995; Griffin and Hauser, 1996).

Previous communication studies have mostly tackled information dissemination between dyads (Gupta, Raj, and Wilemon, 1986; Moenaert et al., 1995; Moenaert and Souder, 1990) or triads (Ruekert and Walker, 1987; Song, Montoya-Weiss, and Schmidt, 1997) by measuring the frequency of communication using key informants without making further precisions on the communication patterns of the constituent individuals embedded in the organization. Also, most of these findings assume that each department involved in NPD brings a fair contribution to the construction of the product. First, we intend to use communication networks to moderate this assumption. Compared to a dyadic relationship, Iacobucci and Hopkins (1992) define a network as "*a composite of a larger number of actors and the pattern of relationships that ties them together*" (p. 5). Rather than focusing on personal attributes, this approach takes the standpoint that the internal structure of collaboration and information exchanges influence decision-making. This is in line with the theory of power influence (Brass, 1984; Pfeffer, 1981), which has also shown its importance in NPD between the marketing and the R&D departments (Atuahene-Gima and Evangelista, 2000). Influence refers to "*the degree to which information offered by participants in the NPD process leads to changes in behaviors, attitudes, and/or actions of the recipient*" (opt. cit., p. 1269). We identify which employees are relatively central during the exchange of product information. According to Powell, Koput, and Smith-Doerr (1996), central employees possess more information and therefore more power. In other words, we aim at identifying which employees and departments have a situational advantage (i.e. relative dominance) in the communication network. This will help us unravel informal dominance within the communication network; especially that at interfaces between product designers and employees from service, sales and marketing,

and other departments involved in information exchanges and – directly or indirectly – in the decision-making process.

- RQ 8: Which employees are central during product information exchanges within the manufacturing organization?

Second, we observe the influences of degree centrality and knowledge absorption on on-going PDD. Individuals embedded in a communication network can learn from others (knowledge absorption), but also create knowledge by teaching others (knowledge creation) (Antonelli, 1997). To unravel knowledge flows, we establish who the main knowledge creators and absorbers are, and where they are positioned in the communication network. Further, we posit that centrality in the network has a dual effect on PDD. The mere proximity to other central actors may influence central actors to be more in favor of design changes because they feel more involved and, therefore, concerned with product success (Salancik and Pfeffer, 1978). We expect degree centrality to positively influence PDD. However, we also posit that the impact of degree centrality on PDD may be mediated by 'experimental learning' or 'knowledge absorption' (Kayes, Kayes, and Yamazaki, 2005). Experimental learning "*focuses on how individuals draw on direct experience with the world to create new knowledge*" (Kayes, Kayes, and Yamazaki, 2005, p. 89). Strong ties in a network have been significantly linked to the receipt of useful information (Levin and Cross, 2004). We posit that the more interactions with network employees (i.e. the higher degree centrality) the higher the experimental learning or knowledge absorption will be. However, too much experimental learning may also affect PDD. Organizing and creating frameworks for understanding knowledge is a necessity to reach experimental learning (Kayes, Kayes, and Yamazaki, 2005). Information overload may complicate the decision-making process and therefore lead to higher design change

resistance (Yen et al., 2006). Thus, we expect an inverted U-shaped relationship between the level of knowledge absorption and PDD. We formulate the following research questions:

- RQ 9: Which employees are knowledge creators and absorbers during product information exchanges within the manufacturing organization?
- RQ 10: Does employee degree centrality during product information exchanges lead to more favorable on-going product design decisions?
- RQ 11: Does employee degree centrality during product information exchanges lead to higher experimental learning?
- RQ 12: Is there an inverted U-shaped function between the amount of experimental learning and on-going product design decisions?

4.4. Methodology

4.4.1. Research Site and Data Collection

To carry out this study, we decided on a rigorous three step approach within a manufacturing firm: (a) in-depth interviews were carried out with managers and employees, (b) a survey questionnaire was sent out to all employees involved with a specific product, which is subject to potential design changes, and (c) a post hoc group feedback session was organized to further discuss our findings with the top management.

The Case Study

One-site sampling was chosen due to the complexity and nature of the research questions (Eisenhardt, 1989), as well as the high response rate imperative of such data collection (Tsai and Goshal, 1998). Potential companies were contacted based on three criteria. With the help of two professional industrial consultants, we first identified firms commercializing (a) industrial products, with (b) in-house service delivery, where (c)

employees were located on the same site. Second, among these companies, we selected – based on annual reports – those that explicitly indicated investing in research and development (R&D) and product development activities. This implied that they would be engaging in PDD. Finally, we contacted companies with relatively lower (but positive) net income over the last three years, which could be the consequence of poorer product decisions.

The selected company is one of the top 10 suppliers of distribution systems in the world. In 2005, the company reached consolidated net sales and net income of approximately € 350 million and € 2 million respectively. In order to reach the company's growth objective, management has continued to invest in R&D. The specific project under study, 'multisorter', which has sold eight units, is a solution for sorting mixed flows from small to large products.

Seven departments are involved in developing, building, selling, and servicing the product: R&D, (operations) engineering, (operations) installation, systems, sales, service, and service development. For clarification purposes, the role of engineering is to build the product. The service department provides maintenance, system updates, repair, but also services such as training, logistics management, and audits. The systems department develops the software that monitors and manages the tracking and dispatch of products.

4.4.1.1. In-depth Interviews

First, we interviewed the heads of the seven departments and employees involved with the 'multisorter' project. Interviews lasted between 45 and 60 minutes. The interviewees had been with the company for 10.8 years on average and comprised of four top managers (sales, R&D, engineering, and systems), three middle managers (service, service development, and operations installation), and two employees (service and R&D). In order

to answer *RQ11*, interviewees were asked to discuss and establish go/go-no criteria that would be evaluated in the decision to proceed with product design changes.

4.4.1.2. The Survey Questionnaire

The survey questionnaire consisted of three sub-sections. A first sub-section collected personal information such as name, gender, department, formal job rank (five levels), and tenure. A second sub-section studied employees' communication frequencies with colleagues and customers regarding the performance of 'multisorter'. Also, respondents named the top three formal decision-makers regarding PDD. The distribution of 'multisorter' customers and employees is presented in Table 7. The 46 employees and eight customers represent the complete network. Lastly, using Likert-type scales, we measured (1) PDD, (2) the extent of support for the go/no-go decision criteria identified during previously semi-conducted interviews, and (3) the relative performance of the current product against that of competitors.

Table 7: Distribution of employees involved with 'multisorter'

Departments	Frequency	Percent
Customers	8	14,8
Systems	4	7,4
Engineering	10	18,5
Installation	2	3,7
R&D	10	18,5
Sales	7	13
Service	11	20,4
Service development	2	3,7
Total	**54**	**100**

4.4.1.3. The Post Hoc Group Feedback Session

A post hoc group feedback session was organized to present our findings to the company. Members of top management were invited to discuss the findings with us and their colleagues.

4.4.2. Unit of Analysis and Data Collection

The unit of analysis is individuals' patterns of information exchanges behavior regarding customer and employee feedback on 'multisorter'. Data was collected via a questionnaire survey distributed via internal mail. After two email reminders and personal telephone calls, we achieved a response rate of 92.6%. Regarding the inclusion of missing employees in the communication network, we observe, first, that these employees could not be excluded given that they had been identified by others as 'communicated with' even though they appeared as peripherals. We then assumed that if 'X' stated that s/he communicated 'x' times with the missing employee 'Y', 'Y' would have stated the same communication frequency 'x' (Borgatti and Molina, 2003). For all other employees, the number of symmetric pairs was 73.87%. Since the measurement for communication frequency did not include directionality, if employees 'X' and 'Y' stated different frequencies of interactions, we contacted both employees to cross-validate their initial input in order to increase the number of symmetric pairs to 100%.

4.4.3. Measurement Properties

Appendix V in the appendix presents our measurement instruments.

Communication patterns. As defined by Rogers and Kincaid (1981, p. 24) "*social network analysis is a method of research for identifying the communication structure in a system, in which relational data about communication flows are analyzed by some type of*

interpersonal relationships as the unit of analysis". This approach is appropriate for our research given that it enables to study knowledge dispersion among all individuals involved in a project (Hansen, 1999) (answering *RQ8* to *RQ12*). Employees were asked to indicate how frequently they effectively interact with colleagues and customers about the current performance of 'multisorter'. We did not expect employees to react defensively to the survey since they had never taken part in organizational social network analysis (Borgatti and Molina, 2003). Also, each employee was asked to rate (on a scale from 1 to 10) how comprehensible the information generated during these interactions were, and whether these interactions communicated important (useful) detail to them about multisorter's performance. Based on these measures, we not only present the architecture of the communication patterns but also identify employees regarded as the most knowledgeable. This means that each employee is given – based on others' reporting – a 'knowledge creation score' and – based on his/her own saying – a 'knowledge absorption score'. If the total number of employees spoken to by an employee *i* is *j*, and the scores given by the *j* employees to employee *i* to establish how much learning happens during their interaction is '*x*' $\in$ [1;10], the 'knowledge creation score' of *i* is calculated as follows: $\sum_{(1 \rightarrow j)} x_i$. The 'knowledge absorption score' of employee *i* is simply the sum of all *x*'s that employee *i* allocated to his/her interactions with the *j* employees of the network s/he communicates with: $\sum_{(i)} x_{1 \rightarrow j}$.

To study employee involvement in information sharing we refer to degree centrality (Freeman, 1979), which is used to compare actor centrality within a single network (Ahuja, Galletta, and Carley, 2003). Degree centrality is defined as "*the number of individuals with whom an actor is directly connected*" (Ronchetto, Hutt, and Reingen, 1989, p. 60). Actor degree centrality calculations were performed using UCINET VI software (Borgatti, Everett, and Freeman, 1999). A social network matrix is a binary matrix with senders on

each row and recipients on each column. The presence of a link between two employees is represented by a '1' in that cell given that directionality was not conferred to information exchanges. With frequency of communication measured on a 7-point Likert type scale, we first consulted our interviewees to determine an appropriate cut-off point to assign a '1' or a '0' on each cell of the matrix. On that basis, a '1' was assigned if the communication frequency was equal to or greater than once a month.

Decision-makers. Each employee was asked to name the top three formal decision-makers engaging in whether the company would make changes to the design of 'multisorter'. Reasons for doing so were the following. First, to identity their department membership and thus functional formal influence in decision-making. Also, to observe if potential decision outcomes vary between groups formed according to the following grouping criteria: (1) degree centrality, (2) knowledge absorbers and creators, (3) formal decision-makers, and (4) the remaining employees in the communication network.

Product design decisions and *go/no-go decision criteria*. The scale measuring PDD was based on the definition of Song and Montoya-Weiss (1998, p. 126). This involves measuring to what extent employees are willing to adapt, refine, and enhance the existing product. This scale is reflective (Jarvis, Mackenzie, and Podsakoff, 2003) and our findings show an alpha reliability coefficient of .79 (Cronbach, 1951). Regarding go/no-go decision criteria, we asked the respondents to what extent each criterion identified during the in-depth interviews would be a relevant factor in their decision-making regarding product design changes. Scales anchoring ranged from '1' (*No, not of concern*) to '5' (*Yes, of very much concern*).

Lastly, we assessed the *relative performance of the current product* against that of competitor products. Based on 'multisorter' catalogue, and by cross-validating important products attributes across department (e.g. flexibility, capacity, reliability, system

availability, serviceability, etc.), we evaluated the extent to which 'multisorter' performs '*much worse*' to '*much better*' than competitor products.

4.5. Analysis and Results

4.5.1. Outcome from the Interviews: Four Go/No-go Decision Criteria

First, confirming previous findings (Carbonell et al., 2004; Zahay, et al. 2004), product acceptance or *product-related* factors appeared crucial to PDD. Product-related go/no-go decision criteria were similar to Bloch's (1995) dimensions of product form: performance, ergonomics, and aesthetics. Aesthetics refer to "*product appearance […] and appeal to the senses*" (Srinivasan, Lovejoy and Beach, 1997, p.155), whilst ergonomics involve "*the matching of a product to the target users' capabilities to maximize safety, efficiency of use, and comfort*" (Bloch, 1995, p.18). Flaws in these aspects are criteria for on-going product design decisions.

Second, service acceptance or *service-related* criteria also appeared relevant in establishing reasons for adapting, refining, or enhancing product design. Service aspects relate to product serviceability and service reliability. As stated by a service employee: *"Service needs to be easy. It is simply too difficult right now since we do not understand the error messages [...] and it needs to be reliable. That's all our customers are asking for, but we need to reconsider the product's design to improve this... This is a key issue of concern!"* Our findings complement those of Zahay et al. (2004) referring to 'customer needs and wants', which also include service aspects. These views, in theory, were shared by all departments showing, a priori, no influence of professional culture. In fact, past research found product design to influence both the amount of service support required and the way it can be delivered (Goffin, 2000; Lele, 1986). Since an increasing number of

product manufacturers across several sectors are developing into total solution providers, it is interesting that service criteria appeared unanimously important.

Third, *market-related* reasons are also a go/no-go decision criterion. Where previous studies found significant support for market-related criteria such as 'market share' and 'sales revenues' in later stages of NPD (Carbonell et al, 2004; Zahay, et al., 2004), seven interviewees suggested that these aspects were (also) evaluated before implementing the fourth phase of NPD. Observes the sales manager: "*we know the product and how it performs in terms of market share. Before we even think of altering it, we think about how these changes will affect market share and sales revenues. I mean, what will be the marginal gain on sales revenues on a five year period?"* The system manager's reflections point in the same direction: "*We sell many products, and the mere fact that we seriously consider a product for re-design means that we have at least established its future sales revenues to some extent."*

Finally, the costs and ability of design changes are taken into consideration. In other words, there are ability constraints to product changes (Dhebar, 1995). Past studies have shown the importance of the cost of changing the product (Schmidt and Druehl, 2005), as well as the company's ability (resources) to do so (Perks, 2000; Sahay and Riley, 2003). Our interviewees confirm the importance of *feasibility-related* aspects. Where Carbonell et al. (2004) refer to these issues as a 'technical' factor; we suggest that the cost of change and the difficulties/resources for design changes are more correctly referred to as the 'feasibility of change'.

Ultimately, we cross-validate our theoretical findings using maximum likelihood with a varimax rotation method with Kaiser normalization (Kaiser, 1958) on the full network sample. Table-A2 of the appendix shows that the number of factors and the loadings of measured indicator variables consolidate the findings from our in-depth interviews.

To answer *RQ7(a)* and *RQ7(b)*, Table 8 presents the descriptive statistics relating to the support for go/no-go decision criteria and PDD. Also, on average, we note that the current relative product performance reaches 2.92 (σ = .42) measured on the 5 point Likert-type scale. The low relative performance confirms management perceptions of the relevance of the research setting.

Table 8: Descriptive statistics for go/no-go criteria support, current product performance (CPP), and on-going product design decisions across departments

Department	**Product**	**Service**	**Market**	**Feasibility***	**CPP**	**PDD**
Sales	1.73 (.43)	3.60 (.89)	3.50 (.77)	2.50 (1.05)	**3.25** (.77)	3.90 (.62)
Service	2.17 (.96)	4.06 (1.18)	2.21 (1.15)	2.00 (.83)	2.71 (.34)	3.98 (.51)
ServiceDvlp	1.33 (.00)	**4.75** (.35)	3.25 (1.06)	2.25 (1.77)	3.00 (.00)	3.71 (.40)
R&D	2.00 (.64)	2.69 (1.46)	2.29 (1.11)	2.11 (.65)	3.05 (.19)	3.37 (.92)
Installation	1.67 (---)	4.00 (---)	3.00 (---)	2.50 (.71)	3.10 (.14)	**4.21** (.30)
Systems	**2.33** (.33)	3.37 (1.38)	**4.00** (1.15)	**1.88** (.85)	2.68 (.22)	4.11 (.32)
Engineering	2.30(1.25)	3.80 (1.00)	3.35 (1.60)	2.15 (.94)	2.78 (.32)	3.97 (.61)
Average	*2.06 (.87)*	*3.62 (1.22)*	*3.01 (1.30)*	*2.15 (.85)*	*2.92 (.42)*	*3.89 (.53)*

**** regarding feasibility, the lower the support the better***

Given that the service, engineering, and R&D departments are the only departments with at least 10 employees, we perform Mann-Whitney U-test in order to compare the support for go/no-go decision criteria between these departments and the rest of the firm. Further, we study the impact of functional membership on on-going product design decisions, as well as on the perception of current product performance. We find that:

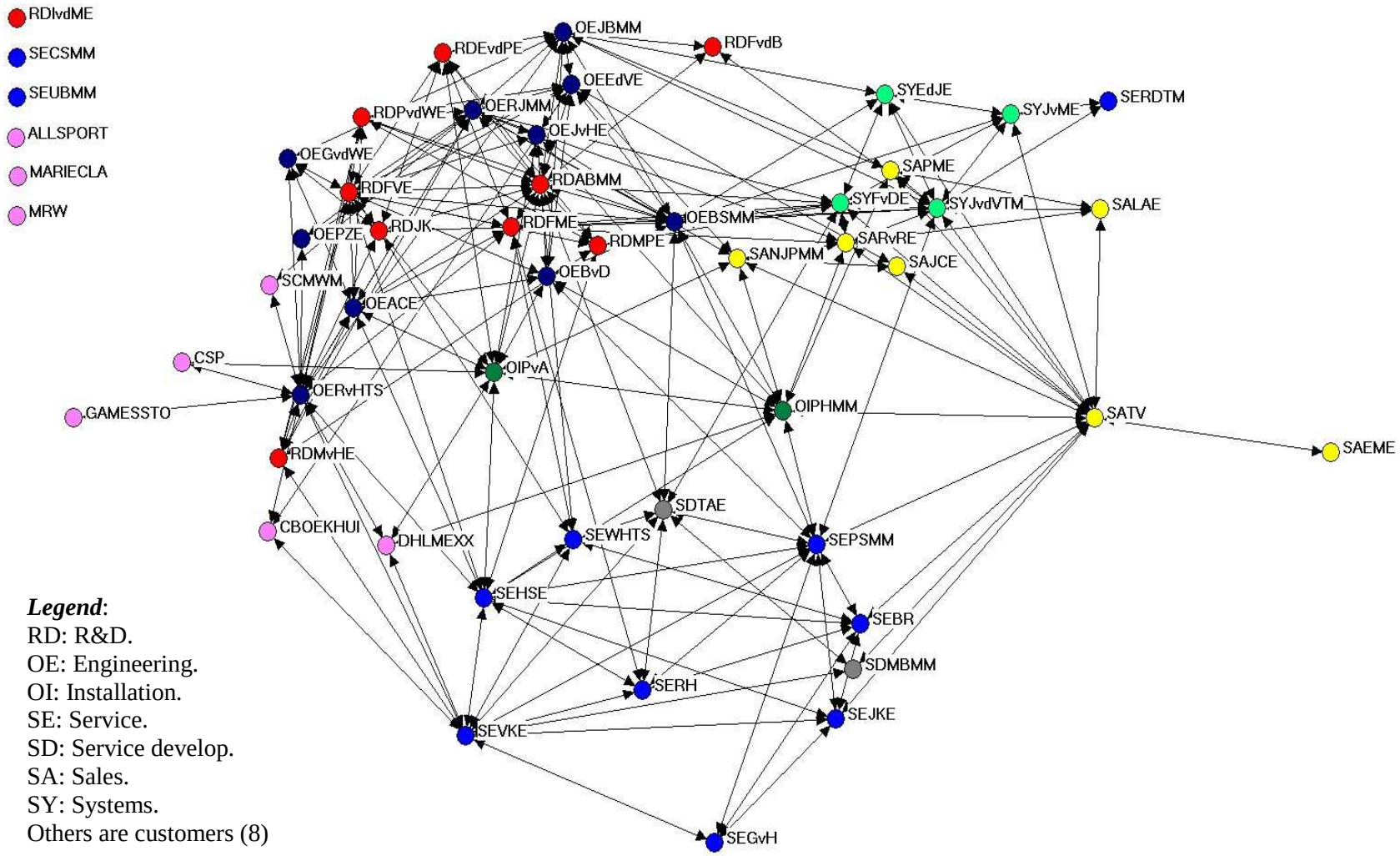
- Service and engineering employees are significantly more in favor of the service-related go-criterion than are R&D employees (respectively Z= -1.908; p= 0.03 and Z= -1.759; p= 0.04);
- R&D employees are significantly less in favor of the service-related go-criterion (Z= -2.103; p= 0.02) and the market-related go-criterion (Z= -1.648; p= 0.05) than are other employees;

- Service employees are significantly more in favor of the service-related go-criterion (Z= -1.951; p= 0.02) and (borderline) significantly less in favor of the market-related go-criterion (Z= -1.505; p= 0.07) than are other employees.
- R&D employees are significantly less in favor of proceeding with product design changes than other employees (Z= -1.835; P=0.04).

We conclude that functional membership, explained by differences in professional culture (Sackmann, 1992), does have an influence on concerns for go/no-go criteria in the decision to proceed with on-going product design, as well as on on-going PDD.

In order to answer *RQ8*, Figure 4 presents the Gower Metric Scaling communication graph. This method plots close together employees who engage in intense information exchanges either directly or through other employees (Verspagen and Werker, 2004).

Figure 4: Social network analysis of information exchanges regarding 'multisorter'.



Legend:
RD: R&D.
OE: Engineering.
OI: Installation.
SE: Service.
SD: Service develop.
SA: Sales.
SY: Systems.
Others are customers (8)

4.5.2. Network Description

The overall network density is .13 with a standard deviation of .34 (Figure 8). Since the data is binary, this means that 13% of all possible ties are represented (i.e. the density of the matrix). There is a great deal of variation between ties because the standard deviation is almost three times as high as the density measure. This involves a rather sparse network with high inequalities of communication patterns. We derive three main observations from the network diagram.

At first glance, we expect the presence of communication cliques, which are defined as a sub-set of actors who are more closely tied to each other than they are to actors who are not part of the group (Bron and Kerbosch, 1973). Based on a clique analysis with a minimum set size of five employees, we identify eight cliques, six of which are solely formed by R&D and engineering employees. This confirms previous findings on the higher frequency of communication behavior within engineering subcultures (Tushman, 1979).

Second, the service department appears marginalized from the back-office (composed of R&D, engineering, and systems). Also, service employees appear to communicate with the back-office mostly via the installations department. This was confirmed by several managers and employees during the group feedback session: *"In this company, one department has to deal with all the problems: installation. They deal with R&D if the product assembly manuals are not clear, with engineering if the product pieces are faulty, with service if service employees cannot perform their job well and have technical questions. Really, installation is always blamed if anything goes wrong and their position in NPD reflects their position in general in this company."* In fact, one notion of how totally connected two actors are (called maximum flow) asks how many different actors in the neighborhood of a source lead to pathways to a target (Ford and Fulkerson, 1956; Gomory and Hu, 1964). For instance, when employee *i* wishes to send information to

employee *j*, the number of neighboring employees through which *i* can be connected to *j* determines *i*'s maximum flow. That is, how connected *i* is in the network. At the functional level, our initial observations are confirmed with the installation department attaining an average maximum flow (334) higher than that of engineering (301), systems (289), and R&D (254). Confirming the significantly more marginal role of the front-office, our results demonstrate that the back-office has significantly higher maximum flow than the front-office (Z= -1.988; p= 0.03).

Third, there is little contact with customers on a monthly basis. There is no significant difference between the frequency of customer communication between the front- and back-office (Z= -.200; p= 0.841). At a department level though, service and R&D employees communicate significantly less with customers than do operations engineering (Z=-1.866; p= 0.06; Z= -2.024; P= 0.04, respectively). During the group feedback session, several top managers acknowledged ignoring engineering had more frequent direct contacts with customers than service employees.

4.5.3. Descriptive: Degree Centrality of Employees in Information Exchanges (RQ8)

We note that the average degree centrality of employees is quite high (μ: 7.07); however, the standard deviation (σ: 4.90) shows that the population is quite heterogeneous in structural positions during on-going product design. The coefficient of variation in communication patterns show high heterogeneity: (σ/ μ) * 100 = 69.27. Further, we observe that the network centralization or concentration as a whole – at the macro level – is very low: 19.45%. This value expresses the degree of inequality of our network with a perfect star network of the same size (Hanneman and Riddle, 2005). In a star network, all actors would have a degree centrality of 1, except the 'star' who will have a degree of the total number of actors minus one (Freeman, 1979). Our findings demonstrate significant

differences between the degree centrality of engineering and the service employees compared to other employees: engineering employees are significantly more central than other employees (Z= -2.262; P= 0.01), while service employees are significantly less central (Z= -1.644; P= 0.05).

Individual positional advantages are unequally distributed as follows. The top 10% of central people are from the following departments: an employee and a middle manager from R&D, two middle managers and a technician from engineering, and the general manager from sales (See Table 9). We conclude that central individuals are mostly employees from the back-office (*composed of 24 employees*) with a technical background.

Regarding knowledge 'creators and absorbers' (*RQ9*), we note that the flow of knowledge seems to be mostly generated by R&D employees and absorbed by engineering employees. Four of the top five knowledge creators are from R&D. Regarding the knowledge absorbers, three are from engineering, one is from R&D, and one is from service (See Table 9). In the following, we compare the formal decision-maker group with our findings derived from the degree centrality measures and knowledge creation and absorption scores.

4.5.4. What about the Formal Decision-Makers?

The top six decision-makers are presented in Table 9. We note that employee centrality measures, knowledge-derived scores, and the formal decision-making power based on the frequency of citation differ. Central and most knowledgeable individuals are in fact under-represented in the formal decision-making group (Table 9).

First, only two employees from the top five knowledge absorbers and the top five knowledge creators are formal decision-makers in the organization. Second, comparing the six most frequently cited decision-makers to the top six central employees, we find that

these groups share only 33.3 % of the employees. Also, the most frequently cited decision-makers are from R&D, engineering, and systems although the service department was identified as one of the four main business units in the company's annual report. These finding show discrepancy between service's actual influence and its projected position during our in-depth interviews. At the same time, this confirms our previous findings regarding the more marginal role of the front-office.

Overall, we demonstrate that employees in Table 9 are mostly from R&D and engineering. However, we found that R&D employees are significantly less in favor of product design changes. Ignoring potential group-effects that may come into play, if employees were distributed in groups as shown in Table 9, the outcome of their support for design changes would vary. We attempt to partly explain these findings by answering our remaining three research questions and observing the potential impact of formal job rank on PDD and go/no-go decision criteria.

Table 9: Willingness to proceed with product changes according to five different grouping criteria

Centrality based (6)	Formal based (5)*	Formal weighted (5)+	Learner based (5)	Teacher based (5)	Rest of firm (37)
RDFVE	RDFvdB	RDFvdB	OEJBMM	**RDABMM**	(ALL excl.
OERvHTS	OEBSMM	OEBSMM	OERvHE	RDFVE	formal-
RDABMM	SYJvdTM	SYJvdTM	OEJvHE	RDFME	based
OEBSMM	**RDABMM**	**RDABMM**	**RDABMM**	RDJK	employees)
OERJMM	OEFvDE	OEFvDE	SEVKE	SEWHTS	
SATV	OEJBMM	OEJBMM			
---	---	---	---	---	---
4.14 (.59)	4.23 (.39)	4.28	4.06 (.54)	3.43 (.48)	3.79 (.67)
Range: *3.57 – 5.00*	Range: *3.71 – 4.71*	Range: *3.71 – 4.71*	Range: *3.71 – 5.00*	Range: *2.86 – 4.00*	Range: *1.57 – 5.00*

* One formal decision-maker did not answer this question.
\+ In order to calculate the weighted effect, we multiple PDD of each formal decision-maker by the frequency of citation by other employees.

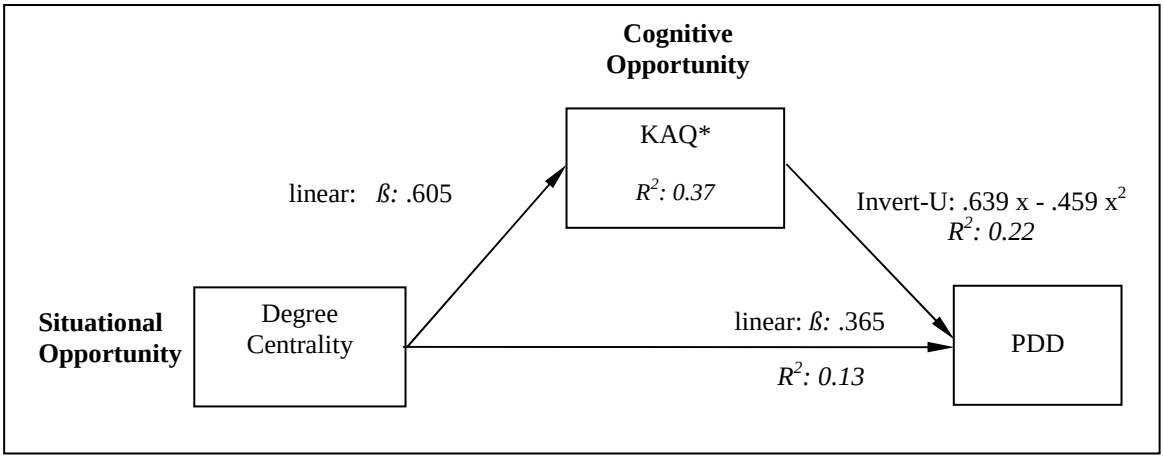
4.5.5. Answering RQ10 to RQ12

With the current sample size, we do not build a structural model. Rather, our findings in Figure 5 are based on ordinary least squares regressions. We confirm the following relationships:

- On-going product design decisions are a linear function of the degree centrality (*RQ10*) and an invert U-shaped function of the amount of knowledge absorbed about current product performance (*RQ12*);
- Learning is a function of degree centrality (*RQ11*).

Our data confers face validity to our findings since other studies have formerly proven the impact of centrality on learning (Hanneman and Riddle, 2005; Levin and Cross, 2004). In contrast to the theory of weak ties (Granovetter, 1973), our data supports that central employees are significantly more knowledgeable about the current product's performance than others. Also, for face validity, we note that frequency of customer contact is significantly associated with the amount of learning (*ß* = .314, *p*= 0.05, R^2 = 0.10). The value of customer information for organizational learning need not be extensively reminded (e.g. Maltz and Kohli, 1996).

Figure 5: The influence of degree centrality on product design decisions.



*: Knowledge absorption quantity

Further, our findings confirm the dual impact of degree centrality; a *situational* opportunity to make changes to the existing product and a *cognitive* opportunity influencing the decision to change product design following an inverted U-shaped function (F= 4.58, p= 0.02). According to the calculation of the function's optimum, the optimum Z-score for the amount of knowledge is 0.69. This means that: ($X_{original}$ – 86.32) / 47.89 = 0.69; where 86.32 and 47.89 are respectively the mean and standard deviation of original scores for knowledge absorption. Thus, employees most inclined to make changes to the existing product are those with total 'quantities' of knowledge equal to: $X_{original}$ = 119 (where observed values range between 23 and 272). If an employee learns to her/his fullest during each individual interaction (10/10), s/he will be most favorable to PDD if s/he interacts with twelve actors of the total network.

Finally, as control, and in order to underline the importance of informal communication patterns, our results show that formal job rank does not have a significant effect on on-going PDD. Also, concerns for go/no-go decision criteria do not significantly differ according to formal job rank.

- Job rank as such has no significant effects on the support for go/no-go decision criteria;
- Job rank as such has no significant effects on PDD.

4.6. Discussions and Managerial Implications

4.6.1. The Impact of Professional Cultures on Go/No-go Decision Criteria and On-going PDD

Professional cultures such as service, sales, or R&D cultures can be distinguished within most organizations (Bloor and Dawson, 1994). A professional culture grows out of the characteristics and skills of the people in the profession. Broadly speaking, Sirmon and Lane (2004, p. 311) state that a professional culture "*exists when a group of people*

employed in a functionally similar occupation share a set of norms, values, and beliefs related to that occupation."

Our findings demonstrate that professional culture can significantly bias the support for go/no-go decision criteria. As such, this would be less of a problem if each organization would involve at least one individual from each functional area in product design decision-making. However, some departments achieve a dominant position in the communication network. This dominance engenders, or is engendered by, a specific corporate culture, which is defined as "*the personality of the organization that is comprised of assumptions, values, norms, and tangible signs of organizational members and their behaviors*" (Schein, 2004, p. 6).

Our study results show that some departments (i.e. engineering, R&D, and systems) are formally more dominant than others. Informally, engineering is in a dominant position. Due to the frequent communication between engineering and R&D, these departments establish the dominant values, norms, and practices of the manufacturing organization. It is key for every organization to identify where formal and informal power resides, as it affects on-going product design decisions. We find that R&D employees are significantly less in favor of changing the existing product than the rest of the firm. This could be explained by the fact that R&D engineers may perceive the current product as 'perfect' regardless of what the customer wants (Shaw and Shaw, 1998). However, our findings suggest a second explanation. Without being significantly more central than other employees – but still reaching high levels of knowledge absorption due to the nature of their relationship with the engineering department – R&D employees fulfil both conditions leading to significantly lower willingness to alter the current product's design.

4.6.2. Integrating Sales and Service Employees in Product Design Decisions.

Bridging the gap between engineering profiles and business profiles is critical for organizations (Johnston, 1989). We are not suggesting to complicate the decision-making process. It is likely that engineering and R&D departments will be central in the majority of manufacturing firms due to the nature of corporate core activity. However, our findings demonstrate the importance of acknowledging and understanding the consequences for decision-making processes.

Prior to this study, the company perceived the front-office as being well integrated in their internal communication and product decision-making. Yet, our results demonstrate that sales and service are under-represented in the formal and informal decision-making process.

We first enquired about the 'integration difficulties' encountered by sales employees. Difficulties were due to a combination of jargon mismatch and the timeliness of receiving the information. Jargon has been identified as a barrier to communication (Griffin and Hauser, 1996). This was clearly the case regarding 'multisorter': "*Our people need to understand fully what they are selling and I must admit that it is not always the case for 'multisorter'. It is a complex product and some sales people do not understand all the technicalities because they are not clearly communicated to us by R&D"* (General Manager, Sales). Confronted with this information during the group feedback session, the R&D director pointed out the second communication barrier between R&D and sales: "*We always send you documents regarding the products. We send them to you and we are ready to explain them to you but you never have time when we offer to help. Then, a few weeks later, you ask for them again, and again, and again"* (R&D director). The quotes suggest a disparity between R&D's and sales' time-orientations or an understaffing of sales people in a technical company. Regarding time orientation, R&D has a long-term horizon (Griffin

and Hauser, 1996), while sales requires on-time information when they are in the process of selling a product. This created communication problems between the two departments. This in turn is problematic for manufacturers because sales people need to make sure that the sold product fits customers' logistics since this will affect product installation and serviceability. Also, sales people can be valuable sources of information regarding customer needs and wants. Therefore, manufacturing companies are advised to shed light on the R&D/sales communication patterns. To effectively manage R&D/sales relationships, manufacturers must create an atmosphere for communication. This is rarely accomplished by means of a quick fix (Patterson, West, Shackleton, Dawson, 2005); interfunctional socialization efforts may provide an organizational method to accomplish this. It fosters goal congruence and process transparency across functionally different subgroups in the innovation process (Harris and Mossholder, 1996). Practically, simply making sure that product information is accessible online for the sales department is an easy way to reduce timeliness problems.

Second, several authors have highlighted the importance of *service* inputs for the organization (e.g. Sampson, 1996; Voss et al., 2004). Additionally, past research found product design to influence both the amount of service support required and the way it can be delivered (Goffin, 2000; Lele, 1986). These findings, and our empirical results, reinforce the role service employees should play in manufacturing organizations. Optimizing service integration does not only require gathering customer information, but also disseminating and using it (Maltz and Kohli, 1996). Therefore, we suggest that manufacturers make sure to include a service employee in decision-making teams regarding product design. His/her role should be to share customer information with the rest of the decision-making team, and ensure that back-office decision-makers do not underestimate the importance of the service-related go/no-go decision criterion. This

mentioned, our study showed that engineering employees had more frequent customer contact than service employees. This could be due to the complexity of the product under study. Also, these findings come as a reminder to manufacturers and academics that (1) the so-called 'back-office' can also be in possession of important customer information and/or (2) that good monitoring of service employees' contacts with customers may be necessary within manufacturing companies.

Third, we highlight the importance of establishing within each department single points of contacts that manages information shared with other departments. Each department should have a 'gatekeeper' (Tichy et al., 1979) for product development communication. A gatekeeper is an individual "*who links the social unit with external domains*" (Tichy et al., 1979, p. 508). This reduces professional culture bias and information overload when the gatekeeper collects and manages information that is shared intelligently and moderately with other sub-units.

4.6.3. The Knowledge Absorption Quantity: Impact on On-going Product Design Decisions

Our results demonstrate that the relationship between the amount of learning and the decision to change the existing product follows an inverted U-shaped function. There are two reasons for that. First, a large amount of learning regarding problems with a product could lead to the perceptions that radical design changes are needed. This engendered much resistance within the R&D department: "*We are not completely changing this product. Before finding all sorts of faults people should read the manuals.*" Second, information overload will reduce on-going PDD. Information overload is the state of an individual (or a system) in which not all communication inputs can be processed and utilized, leading to breakdown (Rogers and Agarwala-Rogers, 1975). Based on past

research, Jones et al (2004) established that information overload is due to the fact that (a) too many messages are delivered and it appears impossible to respond to them adequately; or (b) incoming messages are not sufficiently organized to be easily recognized. In this study, we showed that communicating with a dozen knowledgeable people in the network optimizes PDD.

Having presented these findings, we acknowledge that our findings do not allow us to identify which of the individuals or groups of individuals are right or not regarding 'multisorter'. Indeed, more central employees are more in favor of changes; rightly so? R&D is less concerned with service-related go/no-go decision criteria; rightly so? When passing a threshold for the quantity of knowledge, employees become less willing to change product design; rightly so? We cannot answer these questions since we are studying a hypothetical change and do not know how 'multisorter' would perform on the market if altered. At this stage, however, we can help manufacturers form equilibrated decision-making teams.

4.6.4. How to Assign Decision-makers in manufacturing firms for on-going product design?

First, rather than managers and employees, experts and non-experts must be present in decision-making teams. We do not find support for explaining decision bias with hierarchical levels within the firm. Second, team members should originate from different departments. Second, past research advocates that teams with members of similar profiles may facilitate knowledge transfer, simplify coordination, and avoid potential conflicts (Borgatti and Foster, 2003). On the other hand, limiting communication between dissimilar others prevents a group from reaping the benefits of diversity (Borgatti and Foster, 2003). Based on our results, we show that team member similarity can lead to decision bias. To

facilitate knowledge transfer, departments should assign gatekeepers. Last, team members should belong to the front- and back-office. This finding is derived from the social network analysis, which demonstrates that the front-office was given significantly less importance then the back-office in the communication network. We propose in Table 10 a team composition to decision-making as to reduce potential decision bias.

Table 10: Ideal on-going product design team composition

Team composition guidelines	***Reasons***
1. Experts & non-experts *rather than* employees & managers	Effects of learning quantity *rather than* functional job rank (lack of) influence
2. Different functional areas	Centrality, professional culture bias
3. Front- and Back-office personnel	Centrality, professional culture bias, frequency of customer communication *Illustration* Service employees were less central (-) and had not reached the threshold regarding knowledge quantity (+) leading to a PDD of 3.98. Engineering employees were more central (+) and had past the threshold regarding knowledge quantity (-) leading to a PDD of 3.97. R&D were not significantly more central (-) and had reached the threshold regarding knowledge quantity (-) due to the frequency of communication with engineering employees leading to a PDD of 3.37.

4.7. Research Limitations

The first limitation of this study pertains to the identification of go/go-go decision criteria. Merely two studies have tackled this issue and we needed to insure the relevance of these decision criteria for the specific project under study. Without altering the relevance of our findings, some manufacturers may have different product design decision concerns. Combining our findings with those of previous studies can insure manufacturers to reach a

fuller picture of go/no-go criteria of relevance for PDD. Our guidelines regarding product design team composition presented in Table 10 however remain.

Second, our study was carried out based on a network of 54 actors and differences in support for go/no-go decision criteria and PDD were established based on rather small groups of employees. However, given that we show significant results between rather small groups leads us to foresee that effects should remain for larger departments. This should be further tested though.

Finally, this study was carried out for a single project in one manufacturing firm. We acknowledge that individuals' communication patterns and decision-making may be contingent to the nature and complexity of the product under study (Adler, 1995). We call for a replication of this study in order to increase external validity of our findings.

Chapter 5

General Conclusion and Future Research

5.1. Conclusion to the studies

In this dissertation we focused on studying the antecedents and consequences of service offerings and practices in manufacturing organizations. In sum, the overall objective was to establish how to achieve and profit from service orientations in manufacturing companies. We centered our research questions around the influence of service orientations on product and service success, product design, and product decision-making. We summarize, hereunder, guidelines for manufacturing firms in order to effectively integrate services in product development activities.

5.1.1. Services Strategies and New Product Success

Three main conclusions were drawn from studying antecedents and consequences of service business strategies. First, top management's commitment to service strategies is critical in manufacturing firms. This is especially the case given that instating a service culture – or at least openness to services – is not easy not natural in manufacturing firms (Mathieu, 2001). Our findings in chapter four confirm and exemplify this in the context of product design decision-making. Top management's commitment (TMC) to services influences the support for service rewards and service technologies, which have a significant effect on the support for service business strategies. Also, TMC has a direct effect on service cross-functional communication, which in turn directly influences relative product success. Second, we demonstrate that service business strategies have different effects on relative product success and service profitability. SSP strategies lever service profitability, without significantly influencing relative product success. On the other hand,

SSC strategies lever the relative product success without significantly influencing service profitability. This suggests that manufacturing firms should unravel ways to convert an increased support for SSC strategies into increased service profitability. Third, our findings demonstrate that frequent communication between service employees and the rest of the firm during new product development did not influence the support for service business strategies. This finding confers additional importance to setting up technological service infrastructures and service reward practices in order to achieve greater support for service business strategies.

Given that conclusions at the organizational level demonstrate the importance of service employees for new product success, we expanded our understanding of service orientation by studying the communication interface between service employees and product designers. We address these conclusions hereunder.

5.1.2. Field Service Feedback and New Product Design

First, our findings demonstrate the importance of communication between the service and the design engineering departments. The use of service-sourced information by design engineers in their day-to-day activities has a significant influence on perceived product and service characteristics. In order to increase the USSI by design engineers, we concluded the importance of corporate norms and the attitudes of design engineers towards the service department and service information. Our findings confirmed the importance of top management in motivating their workforce to co-operate during product design. Emphasizing the role of service employees in the planning and development of new products will influence the use of service-sourced information by design engineers. The behaviors, and genuine cognitive involvement, of top managers in DED's processes will provide important role models for their personnel (i.e. Rich, 1997). Also, establishing an

atmosphere for positive attitudes toward the service department is critical. Manufacturers can achieve this by creating functional dependence and reducing perceived conflicts of interest between the service and design departments, as well as by increasing the 'perceived design empathy' of service employees. Second, we concluded that the communication content and communication medium are also party the message as far as the design/service interface is concerned. Indeed, frequent written communication helps getting the message across as designers value written information. Management must think of the right architecture and appropriate incentives to facilitate the dissemination and use of written information. Also, for the specific task of product design, we demonstrate that electronic exchanges of information should not exceed a frequency of three times a week. Regarding the content of the communication, we noted that design engineers tend to hold a negative attitude toward receiving information about product aesthetics. We proposed that manufacturers solve this important issue by creating awareness that accepting field feedback on product aesthetics does not signify that designers will lose their potential for creativity.

5.1.3. Service Communication and New Product Decision-Making

At the individual level, our case study demonstrated the influence of functional membership on on-going product design decisions. First, service employees of manufacturing firms are likely to be confronted with R&D resistance. Indeed, we show that R&D employees are significantly less concerned with service-related go/no-go criterion than service employees – but also than the rest of the firm – regarding product changes decisions. Moreover, while frontline employees will be concerned with adapting product design according to customer demands, it appeared than R&D employees were significantly less in favor of making changes to a product than other employees.

Additionally, service employees appeared marginalized in communication networks within the manufacturing firm. The R&D/engineering culture creates cliques of communication between 'technical employees' that are relatively closed to service inputs. Indeed, the feedback knowledge regarding the project under study was mainly flowing from R&D to operations engineering – leaving little room for service inputs. This was contrary to the perceptions of R&D and engineering employees; but in accordance with service employees' experiences. In fact, only three employees named a service manager as a formal decision-maker. Our findings demonstrated that service employees' informal influence was as low as their formal influence.

Further, we tested overall hypotheses including all network actors in order to establish the influence of communication network positions on product design decisions. We note that employee centrality influences the amount of knowledge individuals can accumulate and their decision to make changes to the product. Centrality confers a situational advantage – that service employees lack in this study – but also hinders the willingness to change product design by creating overloads of product information. This was, on the contrary, not the case for service employees.

Therefore, we formulated general conclusions encompassing functional membership and network positions' influences on on-going product design decisions. We concluded that a diversity of employees must be included into product design decision-making teams respecting the following criteria: teams should include experts and non-experts, employees from different functions, and employees from the front- and the back-office. All criteria must be simultaneously respected to reduce potential product decision biases.

5.2. Future Research

5.2.1. Future Research at the Organizational Level

First, further research could focus on identifying other antecedents to business service strategies. We did not directly include customer demandingness (Li and Calantone, 1998) nor competitor service offers since they emerged as obvious from past research on market orientation (Li and Calantone, 1998; Lukas and Ferrell, 2000). We expect that they will explain, with the identified organizational antecedents in our study, a large proportion of the variance of our focal constructs. Also, customer and competitor orientation will directly influence service profitability and product success (Kahn, 2001).

Second, future research should concentrate on the relationships between our focal constructs, product success, and service profitability. In-depth qualitative empirical studies could generate more insights into the operationalization of SSC business strategies (Christie et al., 2002). For example, an elaborate cost–benefit study could help manufacturers efficiently manage the value of SSC business strategies, which are not (yet) significantly associated to increased service profitability. Also, instead of surveying industrial firms, one could ask industrial customers about their satisfaction levels with the SSC service offerings (Easterly, 2003). Knowing how customers experience value-added services and how the offering and delivery process can be improved is an interesting future study. Along these lines, and in order to insure increased service profitability, one could study the influence of pricing strategies (bundle *versus* non bundle of products/services) and the length, and types, of service contracts on the optimization of service profitability (Kleindorfer and Wu, 2003).

Finally, contextual factors relating to market or relationship characteristics could moderate the intensity of the relationships identified between our focal constructs and their outcome. Past studies have, for example, shown the moderating role of market volatility on

firm performance (Pine, 1993). Regarding relationship variables, and due the nature of SSC offerings, relational aspects such as trust between the customer and the manufacturer delivering the service (Sirdeshmukh, Singh, and Sabol, 2002), the frequency of interactions between these parties, and the absence of mechanisms to resolve eventual conflicts or misunderstanding (Fontenot and Wilson, 1997) could play a moderating role between the support for SSC strategies and the potential to create service profitability.

5.2.2. Future Research at the Functional Level

First, further research should evaluate the effects of moderators on the extent of USSI practices. Wilton and Myers (1986) have provided some evidence that the task situation influences information use. We propose that future research should investigate the role of product complexity on the relationship between the attitude toward the information and the USSI. Product complexity, defined as "*the extent to which a new product being sold is technically complex and sophisticated*" (Atuehene-Gima and Li, 2002; p. 69), is a factor that could affect the use of information. Adler (1995) and Frost and Egri (1991), respectively, have acknowledged the sensitivity to resources among NPD participants and the fundamental functional challenges involved in product complexity. Therefore, one could argue that the higher the design engineers' perceived product complexity, the stronger the relationship will be between the positive attitude toward the information and information consumption. On the other hand, it could also be that the higher the product complexity, the lower the perceived value of support service information by design engineers. As it happens, high product complexity may give design engineers reasons to discount or resist input from service employees.

Second, product newness may also be an issue of concern when manufacturing firms engage in USSI practices. The degree of product newness may vary from being

incremental to radical (Gatignon, Tushman, Smith, and Anderson, 2002). According to Song et al. (1997, p. 126), "*an incremental new product involves the adaptation, refinement, and enhancement of existing products and/or production and delivery systems*." Dewar and Dutton (1986, p.1422) define radical innovation as "*fundamental changes that represent revolutionary changes in technology. They represent clear departure from existing practice.*" This is specifically where conflicting findings emerge from the literature. In effect, no clear and univocal relationship has been established between market intelligence use and the potential to radically innovate. Some authors have argued that market intelligence helps to develop and increase the performance of radical innovation (Chandy and Tellez, 1998), while others found that it reduces it given that companies are likely to miss opportunities that customers cannot describe (Christensen and Bower, 1996). This problem does not occur for incremental innovations (Christensen and Bower, 1996; Slater and Narver, 1995). Along those lines, one could investigate whether the USSI by design engineers affects differently the perceived product characteristics for incremental and radical new product design; if at all for radical product design.

Third, as we examined the impact of service information on a single phase of NPD, additional research could study the impact of service feedback during the idea-generation phase. Further research could also study the impact of information that originates within the service department compared to that originating from other departments on product design. Having previously debated that companies are confronted with the fact that implementing cross-functional communicate between various functions may grow complex, research on the "return on cross-functional communication" may enable manufacturing companies to prioritize – under time and financial constraints – functional interfaces that lever higher product and service outcomes and, thus, higher sales revenues.

Finally, our study offers not only an expansion of existing literature and a model with good explanatory power but also some findings that could be evaluated in the context of support services outsourcing. The questions are: Could service outsourcing hinder the possibility to USSI? If so, how do the benefits of outsourcing weight against the missed opportunities to increase relative product and service characteristics? Studying the impact of corporate governance on the manageability and impact of integrating design and service also remains an avenue for further research.

5.2.3. Future Research at the Individual Level

First, we expect the influence of functional membership and communication network position to influence go/no-go decisions between other stages of NPD. We suggest that future research should make use of SNA in order to unravel informal influences during the idea generation stage. Based on the strength of weak ties (Hansen, 1999), it may be that degree centrality hinders the potential to generate innovative product ideas. The situational advantage – demonstrating involvement – for on-going design decisions on existing products could have a different effect on decision outcomes in other stages of NPD.

Second, future research should evaluate the relative dominance of functional employees for different types of products. Indeed, our study tackles the communication network of a product that is relatively complex for the manufacturer. This may have lead to the fact that service employees were significantly less central than operations engineers in the communication network. Replications of this study for different types of projects should bring more insights in how (informally) central service employees are in manufacturing companies.

Third, future research should further examine the influence of experimental learning on product design decisions. Replications with similar findings would further confirm the

importance of including experts and non-experts in decision-making teams. This is a key finding which needs to be further tested given that it can reduce product decision biases.

Finally, our findings suggest the necessity to study the R&D/sales interface. Establishing how manufacturing firms can better manage this interface is key. Indeed, selling a complex product that does not fully fit customer logistics may lead to problems during product installation, for service reliability, and service quality.

Appendices

APPENDIX I: List of Services Supporting the Products (SSP) (12) and Services Supporting the Clients (SSC) (8).

SSP	SSC
Product documentation	Financing services
Product transportation/delivery	Management of spare parts
Product installation	Process-oriented training (quality-driven including technology)
Help desk/call centre	Business-oriented training (financially driven/management training)
Product inspection/diagnosis	Process-oriented consulting (quality-driven including technology)
Product repair/spare parts	Business-oriented consulting (financially driven/management consulting)
Product upgrades	Managing the maintenance function
Product refurbishing	Fully managing product-related operations (complete outsourcing and ownership of product by vendor)
Product recycling/machine brokering	
Preventive maintenance	
Condition monitoring	
Process-oriented engineering (testing, optimizing and simulating)	

APPENDIX II: Scales of Measurement Items

Scales	Measurement items (Always referring to primary industry segment)
Top Management Commitment (Adapted from Sureshchandar et al., 2001)	Is inclined to allocate resources and time for service management efforts Is dynamic when it comes down to considering service management Evaluates the effectiveness of its personal leadership regarding service management
Service Rewards (Adapted from Lytle et al., 1998)	Management provides incentives and rewards at all levels for service quality, not just productivity We noticeably celebrate excellent service through service reward systems
Cross-Functional Communication (Adapted from Li, 1999)	*To what extent does the (customer) service department and the other departments:* Communicate for new product development Share information on customers Share information about competitors' products and strategies Cooperate in establishing new product development goals and priorities Cooperate in generating and screening new product ideas and testing concepts
Service Technology (Adapted from Lytle et al., 1998)	We enhance our capabilities through the use of "state of the art" technology such as databases containing customer-related information Technology is used to build and develop higher levels of service quality We use high levels of technology to support the efforts of men and women in touch with the customer
Service Strategies (Adapted from Homburg et al., 2002)	Do you offer the following services [list of services presented in Appendix I] If the answer is "yes"; then: • How many customers do you offer this service to? (1 = very few customers to 7 = very many customers) • How proactive are you in offering the service to your customers (1 = very passive; 7 = very proactive)
Relative Product Success (Hultink and Atuahene-Gima, 2000)	*Relatively to your competitors, how has your company (business unit) performed over the last three business years in your primary industry segment in:* Gaining significant market share for new products Generating high level of sales volume for new products Quickly generating sales for new products Exceeding sales targets set for new products Assisting sales manager in achieving the objectives for new products

Service Profitability	*What percentage of your company's (business unit) revenues is generated by services*: less than 10%, more than 10 but less than 20, etc., more than 80 % (8 categories).

Notes: Three items dropped after measurement purification are not included in this table.

APPENDIX III: Standard Loadings, Composite Reliability, and Average Variance Extracted

Construct	Items	Type	Standard Loadings	Composite Reliability	Average Variance Extracted
Top Management Commitment	1 2 3	Reflective	0.89 0.93 0.86	0.923	0.799
Service Rewards	1 2	Reflective	0.93 0.92	0.928	0.865
Cross-Functional Communication	1 2 3 4 5	Reflective	0.76 0.80 0.81 0.85 0.86	0.910	0.669
Service Technology	1 2 3	Reflective	0.91 0.94 0.91	0.943	0.846
Service Orientation Business Strategy (SSP and SSC)	Number of Clients Emphasis on service Proactiveness of the offer	Formative	N.A.	N.A.	N.A.
Relative Product Success	1 2 3 4 5	Reflective	0.84 0.88 0.87 0.91 0.81	0.937	0.748
Service Profitability	1	N.A.	N.A.	N.A	N.A.

APPENDIX IV: Constructs, Items, Scale types, Standardized Loadings, Composite Reliability, and Average Variance Extracted

Construct	items (* indicates dropped items)	Type	Standardized Loadings	Composite Reliability	Average Variance Extracted
Conflict of interest (adapted from Menon et al., 1997; Mohr et al., 1996)	We agree about how we can best achieve our respective goals. (R)	Reflective	0.80	0.852	0.538
	The objectives […] are compatible with those of our department. (R)		0.81		
	Our relationship is market by a high degree of harmony. (R)		0.79		
	There is often tension over the specific terms of our working relationship.		0.62		
	*We argue frequently about product and service-related issues.		-		
	We sense the presence of conflicting interests.		0.63		
Perceived design empathy (adapted from Kohli, 1989)	[…] know a lot about our own activities.	Reflective	0.79	0.913	0.678
	[…] are knowledgeable about our needs with respect to design activities.		0.89		
	[…] know how we operate with regards to our design activities.		0.83		
	[…] have some expertise to understand our design activities.		0.85		
	[…] do not really understand our design activities. (R)		0.74		
	Anchors: Once every three months or less, 1-3 times a month, 1-3 times a week, 4-5 times a week, several time a day (and not available)				
Written info. (adapted from Fisher et al., 1997)	Memos Reports Fax	Formative	n.a.	n.a.	n.a.

Verbal info. (adapted from Fisher et al., 1997)	Formal group meetings Scheduled one-to-one meetings Impromptu face-to-face conversations Scheduled phone conversations Impromptu phone conversations *Tele (video) conferencing	Formative	n.a.	n.a.	n.a.
Electronic info. (adapted from Fisher et al., 1997)	Electronic mail Online data (base) *Anchors: Once every three months or less, 1-3 times a month, 1-3 times a week, 4-5 times a week, several time a day (and never)*	Formative	n.a.	n.a.	n.a.
Content performance (See text for references)	Product compatibility Product durability Product reliability Maintenance/spare parts Mechanical/technical limitations Product operating costs Statistical information (mean time to failure, repair time, etc.)	Reflective	0.77 0.87 0.85 0.71 0.72 0.80 0.68	0.913	0.600
Content aesthetics (See text for references)	Product accessories Product size, shape, color, feel, weight, etc.	Reflective	0.95 0.83	0.888	0.800
Content ergonomics (See text for references)	Product installation Product ease of use Product safety	Reflective	0.93 0.90 0.77	0.902	0.756

Corporate norms (adapted from Hsu and Kuo, 2003)	Those who are important to our department such as top management and colleagues think that we should use information originating from the service department in our design activities.	Reflective	0.95	0.957	0.917
	People whose opinions we value think that we should use information originating from the service department in our design activities.		0.96		
Attitude toward the information (adapted from Maltz and Kohli, 1996)	The information is accurate. The information is clear. The information communicates important details to us. The information reached us on time. We usually intend to use the information […] (conative dimension).	Formative	n.a.	n.a.	n.a.
Attitude toward the department (adapted from De Jong et al., 2004; Ruekert and Walker, 1987)	The service department usually acts in a responsive manner.	Reflective	0.73	0.915	0.609
	The service department assists us well in some of our tasks.		0.75		
	The quality of our relationship with the service department is good.		0.87		
	Our cooperation with the service department is good.		0.84		
	Maintaining a relationship with the service department is worthwhile.		0.66		
	Our department usually intends to collaborate with the service department (conative dimension).		0.75		
	Our department likes collaboration with the service department (affective dimension).		0.82		

	Anchors: Much worse–much better				
Relative product characteristics (adapted from Souder and Jenssen, 1999)	Product quality Product performance Product mechanical features Product technical features Product reliability	Formative	n.a.	n.a.	n.a.
Relative service characteristics (adapted from Zeithaml et al., 1990)	Service reliability Service responsiveness	Formative	n.a.	n.a.	n.a.
	Anchors: Strongly agree–Strongly disagree				
USSI (adapted from Fisher et al., 1997)	[…] leads to concrete actions in designing new products. […] shapes actions regarding the design of new products. […] affects the strategy and practices in designing new products. […] influences our actions in designing new products. […] is used by our department to design new products. […] is rarely used to design new products. (R)	Reflective	0.82 0.88 0.91 0.88 0.88 0.68	0.938	0.719
	Anchors: Very little–Very much				
Functional dependence (Adapted from Fisher et al., 1997)	For your department to accomplish its goals and responsibilities, how much does it need the support service department's: Resources Supports Outputs	Reflective	 0.89 0.87 0.88	 0.867	 0.792

APPENDIX V: Measurement instruments

COMMUNICATION PATTERNS (Internal)

Please indicate how frequently you **interact about work-related matters** with the following colleagues about the MULTISORTER product / solution.

Please also indicate in the last column on a scale from 1 to 10 how much you learn about MULTISORTER 's performance by interacting with each of the colleagues. This score indicates: how clear the information is and whether it communicates important details to you.

The first three lines are presented as an example. If you do not interact effectively with a person, do not fill out anything on that line (just as exemplified in line 2).

	List of Colleagues	*Less than once a year*	*1-3 times a year*	*4-6 times a year*	*1-3 times a month*	*1-3 times a week*	*4-5 times a week*	*Several times a day*	*How much do you learn?*
1	B. Berliz		X						8
2	H. Nambisan								
3	B. Falk				X				4

COMMUNICATION PATTERNS (With customers)

Customers	*Never*	*Less than once a year*	*1-3 times a year*	*4-6 times a year*	*1-3 times a month*	*1-3 times a week*	*4-5 times a week*	*Several times a day*
[NAME OF CUSTOMERS]								

DECISION-MAKERS

Please name the three most important decision-makers when it comes down to deciding whether [Name of the Firm] is going to alter MULTISORTER? Of course, one of the three persons could be you. Please fill in your name if it is the case.

PRODUCT DESIGN DECISIONS

Please state to what extent you agree with the following statements that refer to the current MULTISORTER::

I think that:	*Completely Disagree*				*Completely Agree*
Enhancing MULTISORTER 's design would be good.	1	2	3	4	5
Making some changes to MULTISORTER 's engineering could be beneficial.	1	2	3	4	5
Adapting MULTISORTER could lead to some improvements to the products.	1	2	3	4	5
Adapting MULTISORTER could lead to some improvements to the process.	1	2	3	4	5
Refining some aspects/elements of MULTISORTER would be advisable.	1	2	3	4	5
Refining the product and process is something we should consider for MULTISORTER	1	2	3	4	5
MULTISORTER is perfect as it is; no changes could improve it.	1	2	3	4	5

NO/NO-GO DECISION CRITERIA

If you have indicated above that you would like to see some changes (adaptations, refinements, or enhancements) to MULTISORTER, note your support for the following concerns/reasons:

	No, not of concern		*Somewhat a concern*		*Of very much concern*
Sales revenues	1	2	3	4	5
Market share	1	2	3	4	5
Product serviceability	1	2	3	4	5
Service reliability	1	2	3	4	5
Product performance/capacity	1	2	3	4	5
Product aesthetics for customers (shape, size, frame, side covers, weight, etc.)	1	2	3	4	5
Product ergonomics for customers (installation and ease of use)	1	2	3	4	5
Cost of change for the company	1	2	3	4	5
Difficulty/resources of change for the company	1	2	3	4	5

RELATIVE PRODUCT PERFORMANCE

In comparison to the best competing products on the market, how does MULTISORTER perform on the following dimensions?

	Much worse	*Worse*	*Identically*	*Better*	*Much better*
Solution flexibility	1	2	3	4	5
Material handling quality	1	2	3	4	5
Capacity	1	2	3	4	5
Conveyability	1	2	3	4	5
Information Interface (visualization)	1	2	3	4	5
Reliability	1	2	3	4	5
System availability	1	2	3	4	5
Operating costs	1	2	3	4	5
Design flexibility	1	2	3	4	5
Serviceability	1	2	3	4	5

APPENDIX VI: Confirmatory factor analysis

	Go/No-go Criteria			
	Feasibility	*Service*	*Market*	*Product*
Sales revenues	-,011	,191	**,675**	,350
Market share	-,121	,171	**,966**	,145
Product serviceability	-,159	**,922**	,170	,101
Service reliability	-,238	**,760**	,106	,045
Product performance/capacity	,116	,346	,004	**,930**
Product Aesthetics	-,124	-,059	,288	**,556**
Product Ergonomics	-,110	-,039	,324	**,581**
Cost of change for the company	**,786**	-,276	-,154	-,031
Difficulty/resources of change for the company	**,987**	-,135	-,004	-,076

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Samenvatting

Dit proefschrift levert een theoretische en empirische bijdrage het academische werk dat betrekking heeft op servicegerichtheid tijdens de ontwikkeling van nieuwe producten in productiebedrijven. (*zie* "*call for research*: Homburg, Hoyer, and Fassnacht, 2002"). De servicegerichtheid van productiebedrijven is geanalyseerd op 3 niveaus: organisatorisch, functioneel en individueel.

Ten eerste werd het *organisatorische* niveau bestudeerd. Het doel was om de organisatorische dimensies en de service-bedrijfsstrategieën, die productiebedrijven helpen bij het profiteren van service aanbiedingen en het vergroten van het product succes, te bepalen. Een empirisch onderzoek in 137 bedrijven in Nederland, België en Denemarken toonde aan dat servicebeloningen, servicetechnologieën, en de betrokkenheid en vooruitziende blik van het hogere management, van belang zijn voor de implementatie van servicebedrijfsstrategieën. Bovendien werd aangetoond dat het aanbieden van bezorgings-, onderhouds- en reparatiediensten leidde tot een hogere service winstgevendheid, maar geen invloed had op het succes van het product in de markt. Financiële- en adviesdiensten zorgden niet voor een significante toename van de winstgevendheid van de service, maar deze hadden wel een positieve invloed op het succes van de producten van de fabrikant. Ook functie-overschrijdende communicatie tussen servicemedewerkers en de rest van het bedrijf droeg direct bij aan een verhoogd succes van het product, maar het had geen invloed op de organisatorische steun voor service-bedrijfsstrategieën.

Ten tweede werd de servicegerichtheid op het *functionele* niveau tussen de service- en de ontwerpafdelingen bestudeerd. Het doel van het onderzoek op dit analyseniveau was het identificeren van de antecedenten en het evalueren van de consequenties voor product en

service kenmerken doordat ontwerpers gebruik maken van informatie afkomstig van service (USSI). Productontwerp beïnvloedt zowel de hoeveelheid als de kwaliteit van de service die geleverd wordt aan gefabriceerde producten, daarom is het nuttig voor ontwerpers om bij het ontwerpen van nieuwe producten gebruik te maken van service feedback uit het veld. Een empirisch onderzoek van 121 ontwerpers in de VS toonde allereerst aan dat het creëren van een gezonde werkrelatie tussen ontwerpers en service medewerkers cruciaal was, omdat ontwerpers op deze manier gemotiveerd werden om gebruik te maken van informatie die afkomstig was van de serviceafdeling. Deze informatie had een positieve invloed op productkenmerken en service betrouwbaarheid en ontvankelijkheid. Ten tweede werd duidelijk dat ontwerpers de voorkeur gaven aan geschreven informatie. Houdingen ten opzichte van elektronische informatie werden negatiever wanneer de optimale communicatiefrequentie van één tot drie elektronische uitwisselingen per week overschreden werd. Ten derde werd aangetoond dat informatie over de *ergonomie* van producten een *positieve* invloed had op het beeld dat de ontwerpers hadden van de informatie. Informatie met betrekking tot *productesthetica* had juist een *negatieve* invloed op dat beeld. Tenslotte werd getoond dat ontwerpers het ontvangen van prestatiegerelateerde terugkoppeling van servicemedewerkers niet konden waarderen.

Als derde studie werd de servicegerichtheid binnen productiebedrijven op het *individuele* niveau bestudeerd. In dit onderzoek is er specifieke aandacht gegeven aan de percepties en de rol van servicemedewerkers. Het doel was om de invloed van de servicegerichtheid op langlopende productontwerpbeslissingen (PDD) te analyseren. Productbesluitvorming is cruciaal voor productieorganisaties, omdat veel nieuwe producten tekortschieten wanneer ze op de markt zijn gebracht (Cooper, 2001). Derhalve kan deze studie productiebedrijven assisteren bij het vergroten van de winstgevendheid van het product. Ten eerste werden ja/nee besluitcriteria geïdentificeerd die een rol spelen bij het maken van PDD. Product-,

service-, markt- en uitvoerbaarheid-gerelateerde criteria kwamen naar voren. Ten tweede werd aangetoond dat functioneel lidmaatschap binnen de organisatie een significante invloed had op de betrokkenheid en steun voor ja/nee besluitcriteria. Ook werd aangetoond dat functioneel lidmaatschap en posities in het communicatienetwerk, d.w.z. de centraliteit van een medewerker, invloed heeft op PDD uitkomsten. Twee effecten van de mate van centraliteit werden aangetoond: (1) een situationeel effect, dat leidde tot hogere PDD; (2) een cognitief effect, dat een omgekeerde U-vormige relatie liet zien tussen de absorptie van kennis met betrekking tot de huidige prestatie van het product in de markt enerzijds en de voortdurende PDD anderzijds. Uiteindelijk stelden de bevindingen ons in staat om richtlijnen te formuleren om zo de PDD vooroordelen te verminderen en bijgevolg de winstgevendheid van nieuwe producten te vergoten.

Summary

This dissertation has made a theoretical and empirical contribution to the academic work pertaining to service orientations during new product development in manufacturing companies (*see call for research*: Homburg, Hoyer, and Fassnacht, 2002). We studied service orientations of manufacturing firms at three levels of analysis: organizational, functional, and individual.

First, we carried out research at the organizational level. We defined the organizational dimensions and service business strategies that help manufacturing firms profit from service offerings and increase product success. An empirical study in 137 firms in the Netherlands, Belgium, and Denmark demonstrated the importance of service rewards, service technologies, top management commitment and visionary leadership for the implementation of service business strategies. Furthermore, we found that offering delivery, maintenance, and repair services related significantly to higher service profitability but not to product success on the market. Financial and consulting services did not significantly increase the service profitability, but influenced the success of manufacturers' products. Also, cross-functional communication between service employees and the rest of the firm directly increased product success, but did not influence organizational support for service business strategies.

Second, we studied service orientation at the functional level between the service and design engineering departments. The aim of this study was to identify the antecedents and evaluate the consequences of the use of service-sourced information (USSI) by design engineers on product and service characteristics. Product design influences both the quantity and the quality of service delivered on manufactured products, so it makes sense

for designers to use field service feedback information to design new products. An empirical study of 121 design engineers in the USA demonstrated that creating a healthy working relationship between design and service engineers was crucial because it motivated designers to use the service-sourced information disseminated to them. This information positively influenced product characteristics and service reliability and responsiveness. Second, design engineers valued written information most. Attitudes toward electronic information decreased after an optimum communication frequency of once to three electronic exchanges per week. Third, information about product ergonomics positively influenced designers' perceptions of the information, whereas information on product aesthetics negatively influenced their perceptions. Finally, it appeared that design engineers were not appreciative of receiving performance-related feedback information from service employees.

Finally, we tackled service orientation within manufacturing firms at the individual level and its influence on on-going product design decisions (PDD). Product decision-making is critical for manufacturing organizations since many new products fail once in the market (Cooper, 2001). This study aims at helping manufacturing firms increase the probability of product success. First, we identified go/no-go decision criteria taken into consideration when making PDD. The following were identified: product-, service-, market-, and feasibility-related criteria. Second, we demonstrated that functional membership within the organization had a significant influence on the concern/support for go/no-go decision criteria. Lastly, we showed that functional membership and communication network positions – i.e., employee degree centrality – influenced PDD outcomes. We showed two effects of degree centrality: a *situational* effect that lead to higher PDD, and a *cognitive* effect, which demonstrated an inverted U-shaped relationship between the absorption of

knowledge regarding the current performance of the product in the market and on-going PDD. Ultimately, our findings enabled us to formulate guidelines in order to reduce PDD bias and, therefore, increase the probability of new product success. In our study findings, we paid specific attention to the perceptions and role of service employees.

About the Author

Michael Antioco was born in Brussels (Belgium) on September 15th 1978. In 1996 he graduated from the Collège du Christ-Roi in Ottignies (Belgium). The same year he started his studies at the 'Facultés des Sciences Economiques, Sociales et Politiques' at the Catholic University of Louvain. By September 2002, he had received a Bachelor of Commerce and a Master of Business Science from the IAG Louvain School of Management, Catholic University of Louvain. As part of his curriculum he also studied International Business during an academic year (1999-2000) at the Sophia University of Tokyo (Japan). Following upon that, he carried out his final thesis project at Ion Beam Applications International Headquarters (IBA) in Louvain-la-Neuve (Belgium) where he established the feasibility of investing in Position Emission Tomography in the Japanese market. Also, during his studies, he carried out internships at Hewlett-Packard (Brussels) and Bestfoods Ireland (Dublin) in order to gain practical experience.

In September 2002 Michael started working as a PhD student for the 'Eindhoven Centre for Innovation Studies' (Ecis) at the Faculty of Technology Management at the department of Organization Science and Marketing; Eindhoven University of Technology (the Netherlands). During the course of his dissertation he was a visiting doctoral student at Purdue University (USA) from November 2004 until February 2005. As of September 2006, Michael is employed as an assistant professor of marketing at the IESEG School of Management, Lille Catholic University (France). His research interests are mainly in new product development, knowledge management, and service and market orientation. He will mainly be teaching courses related to operational marketing, industrial marketing, and new product development. He will be living in Lille (France) as of September 2006.

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