The impact of supply chain information and networking on product development in Swedish process industry

Diana Chronr

Industrial Organisation, Lule University of Technology,
S-971 87 Lule, Sweden

Fax: +46(0)920492339 E-mail: Diana.Chroner@ies.luth.se

Abstract: This paper will test the hypothesis that upstream companies in process industries that have changed their strategy to encompass a customer/product focus during the 1990s have also invested in and use some type of information systematisation (e.g. databases) in development. If there has been a change of strategy, then this should imply a need of changing information into development projects through networks. An increased awareness of supply chain information might support and facilitate a change of development perspective. An interesting finding in the paper is the tendency for upstream companies, compared to downstream companies, to be more interested in working in networks to acquire new competences in development projects. This can be since the information needed in projects has changed, thereby increasing the need for upstream companies to find suitable partners when it concerns both suppliers and customers, but also with other actors who can give the needed information. Today, the dilemma for process industries is that much development work requires personal contacts with customers without having suitable information technologies that support that linkage. Therefore, to reach a market-oriented perspective in development, management should, early in the process of strategy change, emphasise evaluation of needed networks and IT systems to make the development process more efficient.

Keywords: information systematisation; network; process industry; product development.

Reference to this paper should be made as follows: Chronr, D. (2005) 'The impact of supply chain information and networking on product development in Swedish process industry' *Int. J. Logistics Systems and Management*, Vol. 1, Nos. 2/3, pp.127–148.

Biographical notes: Diana Chronr is a PhD student at Lule University of Technology where she is writing a dissertation on product development work in process industry. She is also a Lecturer in the Department of Industrial Organisation in the areas of technology management and manufacturing strategy.

1 Introduction

During the last two decades, academic researchers have shown an increasing interest in investigating inter-organisational interaction and the functioning of networks in product development in the manufacturing industry. Today, process industries, like the steel and

paper industries are closing in on other manufacturing industries in the need to develop more 'customer-specific' products. This means that process industries need to change their tradition and working methods. There is indication that the Swedish process industry has changed its focus in development towards a more customer focus and therefore also a shift of strategy (Chronéer, 2003). But how can this task be achieved and what role have information technologies played in this change of development focus and strategy? What role can supply chain information play in this change towards more value added products and an increased collaboration?

This paper investigates some of the impacts of a changed perspective in development for process industries, i.e. if this change has impacted on the use of information systematisation and the view of networks in development projects.

The process industry is a mature industry, where products and production processes are regarded as stable. The characteristics for process industry have been stable markets, fixed production processes with a focus on economies-of-scale, and cost-efficiency. However, this tradition to solely concentrate on the process development and hunt costs has changed. Process industry is a term that has come to symbolise an industry that has invested heavily in its technology, but which has a dilemma in balancing the need to develop more customer-specific products and keep the costs down with process development.

An important aspect in product development is to understand and manage customer and technological competences (Danneels, 2002). So, the fact that product development work in process industries incorporates a deep understanding of the entire supply chain is elaborated in this paper, since current product development is about sharing information and building suitable networks essential for successful developmental work. Christopher's definition of supply chain management has therefore been adopted in this paper:

"The management of upstream and downstream relationships with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole." (1998, p.18)

Product development in process industry is to some extent about managing upstream and downstream relationships. By encouraging the integration of suppliers within the development process, primarily by establishing appropriate partnerships, a wide range of benefits have been achieved in both the process and development of products. Although supply chain management is a universal business practice, Jones (2002) states that comparatively few organisations have achieved effective supplier involvement in product development.

Networking, collaboration and management of supplier and customer relationships are by no means new issues in management research. However, companies in the process industry seem to be entering a new era where traditional relations are being replaced by networks of interrelated companies and other actors, e.g. research institutions, universities, and governmental agencies. In networks, people collaborate with clients, customers, vendors, suppliers and even competitors. IT can be a means for achieving higher degrees of efficiency and effectiveness, but the effects are hard to achieve and measure because information technology requires new skills and capabilities from the personnel to function well. If the organisation structure is not changed the use of IT might be rather pointless (Doherty and Symne, 1995).

This paper starts with a discussion of the theoretical framework with following sub-sections: the role of IT in the organisation, the role of networks and collaboration in product development projects, and finally a brief discussion about supply chain management.

A great amount of research on how to perform product development in the manufacturing industry exists. However, there is limited research on how the process industry should conduct product development. Therefore, the theoretical framework is followed by a brief discussion of the context of the process industry in order to introduce the reader to some special characteristics. Further, there is a discussion of some of the definitions used in this study and a conceptual framework illustrates the hypothesis tested in this paper. The fourth section consists of the methodology and the sample used to collect the data. The final sections present the results and the contribution of the work to both academia and industrial practitioners.

2 A literature review and a conceptual framework

2.1 The role of IT in the organisation

Research shows that IT can be a tool to enhance organisational performance (Doeherty and Symne, 1995). But does the use of IT enhance collaboration and affect a company's strategy? Dewett and Jones suggest IT as a variable that can be used to enhance the quality and timeliness of decision making, thus promoting organisational performance (Dewett and Jones, 2001). They examine IT as a moderator of the relationship between organisational characteristics and several organisational outcomes, most importantly, efficiency and innovation (Figure 1).

Figure 1 The role of IT in the organisation

Source: Dewett and Jones (2001).

Dewett and Jones note that, theoretically, IT must be tightly coupled with strategy because IT affects strategy and strategies have IT implications (2001). Further, they indicate that IT can be instrumental in both shaping core capabilities and integrating capabilities into the organisation context, making them apparent at all organisational

levels. Gunasekaran and Nath (1997) state that IT can/should affect a company's strategy because new changes for a company, like introduction of suitable IT-tools, are interrelated with the company's strategy and supply chain.

Research also shows IT perhaps simultaneously being an enabler and a strategic instigator of a new organisation form (Jarvenpaa and Ives, 1994). The activities of independent nodes in a network can be coordinated through a continuously updated information system so that contributions can be mutually and instantaneously verified. IT can act as a coordinator of activities because IT renders the coordination of inter-organisational activities possible, which is the core of supply chain management (Levary, 2000).

As shown above, IT can enhance collaboration and coordinate activities. New product development, for example, is often a collaborative process, with customers and suppliers contributing complementary knowledge and skills. In almost every industry, it is no longer sufficient to focus on internal productivity. Collaboration with customers, suppliers, and other firms is the key to future prosperity. However, IT cannot always substitute for face-to-face communications, though according to Scott, management needs to create a culture that knows how to exploit IT (2000).

Today, many manufacturers are moving their relationships with component suppliers away from 'traditional arm's length relations driven by a competitive logic toward new arrangements based on a cooperative logic.' (Bensaou, 1997) These take the form of complex cooperative relationships, also described as 'value-adding partnerships' or 'alliances'. An important result from Bensaou's study is that information technology is a significant determinant of interorganisational cooperation.

2.2 The role of networks

Managing complex networks is one of the key factors to 21st century innovation success (Rycroft and Kash, 1999). Successful innovation of complex technologies can sometimes require equal complex networks of firms and other organisations, often including universities and institutions. This can be addressed to companies that must achieve organisational changes due to a need to change their products' added value.

Some forms of integration, internal and external, identified in the literature include: *R&D/manufacturing/marketing integration* (Bondra and Davis, 1996; Fischer et al., 1997; Kahn, 2001; Olson et al., 2001; Song et al., 1997, 1998), *R&D/marketing integration* (Griffin and Hauser, 1993, 1996; Krkkinen et al., 2001; Ottum and Moore, 1997; Song et al., 1996), *supplier integration* (Araujo et al., 1999; Bruce et al., 1995; Hartley et al., 1997; Ragatz et al., 1997; Swink and Mabert, 2000), *customer integration* (Bailetti and Litva, 1995; Butscher and Laker, 2000; Campbell and Cooper, 1999; Dwivedi and Sharma, 2002; Gruner and Homburg, 2000; Mello, 2001; Pick, 1999), and *strategic partnership* (Comer and Zirger, 1997; Littler and Leverick, 1995; Magrath and Hardy, 1994). Other examples is research about co-location (Lipnack and Stamps, 1997; Kahn and McDonough, 1997; Patti et al., 1997), and factors for success or failure (Balachandra and Friar, 1997; Bruce et al., 1995), and joint ventures (Littler and Leverick, 1995). However, few papers discuss a change of development focus in the process industry and the consequences that a change of focus (towards a more customer orientation) can have on the use of formalised information systematisation.

What is a network? Håkansson and Ford state that a complex market can be seen as a network, where the nodes are business units – manufacturing and service companies – and the relationships between them are the threads (2002). Each node or business unit, with its unique technical and human resources, is bound together with many others in a variety of different ways through its relationships. Although management of supplier and buyer relationships is by no means a new issue in marketing (Håkansson, 1990), we seem to be entering a new era where traditional relationships are being replaced by networks of interrelated companies and other actors, such as research institutions, universities, and governmental agencies.

There are many advantages of collaboration in product development work. Littler and Leverick emphasise it as a possible means to secure access to technologies, skills, or information, to share the costs and risks of product development, and to reduce the time taken to develop the product (1995). The negative effects of collaboration can lead to a considerable loss of control over the development in question, and the leakage of information and skills to a partner. Collaborators may even acquire tacit knowledge and learning from partners to the extent that those unique key competencies can be lost. Therefore, the choice of collaborators and partnerships must be considered very thoroughly.

The problem of customer collaboration is that many organisations do not know what kinds of customer information they ought to be collecting, they do not have the skills to do so even when they do know, they do not have formal processes designed to capture important customer information, and/or are in too much of a hurry to move from ideation (i.e. idea generation) and screening to development phases of New Product Development (Flint, 2002).

Suppliers also play an essential role in networks today when the development process is concerned. Development by supplier has become a viable supply chain management practice across firms from several industries that continue to focus on their core competencies and outsource a significant percentage of the costs of goods sold (Krause and Scannell, 2002). In many industries, manufacturing companies give suppliers increasing responsibilities regarding the design, development, and engineering of components (Wynstra et al., 2001). Supplier involvement in product development holds great potential in the short and long run, but few companies seem to be able to realise these benefits.

2.3 Supply chain management

The flow of information in supply chain relationships has changed over the years. Traditional supply chain relationships, that captured data from sales, were later transferred to suppliers, manufacturers, or distributors. Today, new technologies enable customer-related information to be sent directly to suppliers, manufacturers, and distributors, who can then use this information to respond instantaneously to changing inventory levels. This represented the beginning of a supply chain management revolution to capture and diffuse customer trends and preferences deep into supply chain member companies (Bechtel and Jayaram, 1997). Another key supply chain issue involves supplier integration into new product development and the value of information such as inventory, lot size, transportation, etc. (Simichi-Levi et al., 2003). The supply chain recognises that there are cooperative arrangements tying firms to each other and their success to the chain as a whole. The supply chain embraces the entire set of processes

and organisations from source to final customer; this orientation extends beyond the flow process itself. Schary and Skjøtt-Larsen (1995, p.302] point out that the supply chain includes structure, processes of supply operations and the organisation of business units in an integrated network. This arrangement relies heavily on information and coordination instead of direct authority relationships and hierarchical control.

From a review of the supply chain management concept, Persson (1997) points out that coordination and integration between companies along the supply chain necessitates reducing the number of suppliers. But, in order to achieve coordination and integration along the material flow and end customer focus, sharing of information between members in the supply chain is fundamental.

However, supply chain management offers an opportunity to depict the synergy of both intra- and inter-company integration and management (Lambert et al., 1998), since supply chain management represents a way of managing business and relationships with other members of the supply chain. Inter-company integration and coordination via information technology has become a key to improved supply chain performance (Barut et al., 2002).

Tatikonda and Stock (2003) summarise that a supply chain is a network of organisations involved, from beginning to end, in transforming and transporting materials and information to ultimately create and deliver a valued product to end customers. Firstly, because information and materials flow up and down the supply chain. Secondly, each organisation creates and adds value to the entire product in the supply chain. Thirdly, the supply chain is a network of organisations where individual organisations must interrelate and interact to add value.

3 Process industry – the context for this study

The key business challenge in process industry and other industries in the 21st century will be the same as for the latter part of the 20th century, i.e. to be competitive and to be profitable in rapidly changing markets. But to achieve this, it is required for companies to understand their changing environment and to use these changes (e.g. in markets) to their advantage. This implies development of both the technology and the product concept that anticipates and influences customer needs, as well as technology that respond to them.

Do the characteristics of an industry have implication for the development of a product? A product in the process industry is often characterised as of low-technology, long product life cycle, fairly long product development time etc. However, this is about to change for Swedish companies dealing with products that require development of material properties. But it is not easily changed. The underlying assumption is that since product and process are symbiotically related in the production system, then fundamental changes in the one must incite parallel fundamental changes on the other (Etienne, 1981). A product in the process industry can be very complex due to its material property complexity, e.g. a tyre is the end result of complex chemical and engineering processes, which must resist extremes of heat, cold, and stress (Ita and Gross, 1995). One property change can affect the entire product concept.

If a company in the process industry finds it is impossible to compete with high-volume products, then it must find an approach to develop more value-added products, e.g. niche

products. This means improved functionality, features, and performance. But changes in the content of product development for the company in the process industry (e.g. that a product can include both the physical product and a service attached to it) will have implications on shorter lead times, more efficient and/or flexible use of process equipment, more specialty products, consistently high quality products, adaptable operating systems (linked to market activity), and integrated supply chain systems (Guy and Eng, 1994; Harkins and Dubreuil, 1993). This also requires sustainable networks with both suppliers and customers.

3.1 The industries in the study

What are the characteristics of the selected industries in this paper? Below is a general description of the following industries: mining, steel/metal, pulp/paper, chemicals, rubber, plastics, and food/dairy industry.

Companies in the mining industry can be engaged in the mining, processing, and selling of metals and minerals; for example zinc, copper, and gold. Process development is of importance in this type of industry because of products with low functional content.

The Swedish steel industry focuses largely on special purpose products requiring very high quality. The industry's continuing competitiveness entails substantial investment in research and development. Stainless tool and high speed steels represent important types of Swedish specialty steels. Besides manufacturing steel in the form of sheet, strip, wire, and so on, specialty steel mills carry out extensive production of fabricated goods.

Today's paper industry products can be complex, e.g. a package consists of more than just a paperboard. It is a construction that is glued together, on which information is printed, and perhaps containing a barrier in the form of plastic or metal foil. The paperboard must perhaps be able to remove flavours from the food in the packaging, requiring a specific know-how. Knowing how different parts of the package influence each other and eventually how consumers perceive what is in the package is vital.

Examples of products in the chemical industry include liquid and powder coatings for industrial application, paints and adhesives, surfactants, chemicals and systems for environment compatible pulp bleaching processes, as well as chemicals and systems for paper making.

Within the rubber industry, industrial know-how and state-of-the art polymer technology is of importance. Customers can be within the automotive, engineering, chemicals, building, and construction industries. A development area can be compression-moulded products in polymer material.

Development areas in plastics might concern injection-moulded plastic items as customer-specific tasks involving thermosetting plastics and thermoplastics – from idea stage to finished product.

The trend in the food/dairy industry is towards more sophisticated products. Development work today requires other competence aspects, e.g. behavioural science. That is, competence about how a customer thinks and act, which will give a better understanding of why a customer pick a specific product. A product today can consist of other aspects than just the physical content. That is, a product can involve aspects such as packaging, convenience, etc.

3.2 Definitions in the study

In this paper, the definition of process industry is a type of business that has a focus in material/metallurgical/chemical properties and production process in product development projects, i.e., product development and process development are close interrelated. It can be described as follows:

“Process Industry is production Industry using (raw) materials to manufacture non-assembled products in a production process where the (raw) materials are processes in a production plant where different unit operations often take place in a fluid form and the different processes are connected in a continuous flow.” (Lager, 2002, p.108)

Several conditions distinguish process industry from other manufacturing industries (Tottie and Lager, 1995), such as:

- process industry is often a part of a long customer/supplier chain that does not always have access to information from the end-user
- suppliers often deliver material, not components.

The definition of information technologies in this paper concerns all types of systems that can collect, systematise, and distribute information to development projects, e.g. databases.

Respondents were asked if they had some kind of formalised systematisation and distribution of information regarding development work in their projects. The definition of information systematisation includes all kinds of databases or other techniques that somehow systematise information in development projects in a formal way. For instance, development teams may have access to a database where information is collected and can be distributed to those involved in development work. However, an example of ‘non-formalised’ systematisation is when information is not documented and not easily retrieved.

Further, there is no major distinction between ‘product focus’, ‘customer focus’, and ‘value-adding’ in this article, since the respondents randomly used these terms. But it is important to note for further discussion that the concepts customer-oriented (customer-led) and market-oriented can have different meanings for various researchers. Slater and Narver emphasise the importance to not confuse the concepts customer-led and market-oriented (1998). They indicate that scholars discuss two separate management philosophies, i.e. ‘customer-led’ is a short-term philosophy in which organisations respond to customers’ expressed wants, and ‘market-oriented’ represents a long-term commitment to understanding customer needs and to developing innovative solutions that produce superior customer value.

The definition of networking is based on the respondents’ views of working in networks concerning development. The company is coded as ‘working in networks’ if they state that competence, in some parts, is acquired through universities, institutions, or other actors with the required competence for the development work.

3.3 The conceptual framework

The purpose of this paper is to investigate the relationship between a changed perspective (towards a more product orientation) in development for companies in the process industry, especially for upstream companies, and the impact this change has on the use of information technologies and the view of networking today (Figure 2). What role does

IT play in a change of direction from process-oriented development to product-oriented development for traditional upstream process industries?

Figure 2 The hypothesis in the research project

From three decades ago, traditional process industries, like steel and paper industries, had stable markets and were mostly concerned with process development focusing on economies-of-scale, i.e. to manufacture products at as low a price as possible. But today these industries are also affected by the rapid changes in both their markets and technology. This means that companies must have an increased awareness of the product's place in the supply chain, thereby having implications in their role towards customers and suppliers, and impacting the needed information in product development teams so that they can cope with this change.

The main focus in this paper will be on the current trend of product-focused development projects in process industries, i.e. how companies in the process industry change their mind towards value-added products and the implications of this change on development work and what role information technologies have played in this change of development focus. This research project will test the hypothesis that upstream companies in process industries that have changed their strategy to encompass a customer/product focus during the 1990s have also invested in and used some type of information systematisation (e.g. databases) in development. If there has been a change of strategy, then this should imply a need of an information change into development projects through networks.

To test the hypothesis, Galbraith and Kazanjian's categorisation of companies in the supply chain (1986) according to upstream and downstream characteristics, is used. That is, some fundamental differences illustrate the contrast between upstream and downstream companies. Galbraith states that downstream stages add value by producing a variety of products to meet varying customer needs. The downstream value is added through advertising, product positioning, marketing channels, and R&D. Further, Galbraith points out characteristics as standardisation, line-driven organisation, process innovation, capital intensive, and technological know-how to illustrate upstream companies. By contrast, downstream companies are more concerned about customisation, line/staff (they produce multiple products requiring larger staffs), product innovation, people intensive (critical skills centre on human resource management), and market skills. This position in the supply value chain is not easily changed. So, is there any difference between upstream vs. downstream companies when it concerns the use of information systematisation and networking?

4 Methodology

The results in this paper are based on a survey among 50 companies in the process industry. The study has a more quantitative approach with the perspective on development projects (Table 1).

Table 1 The composition of the study incorporated in this paper

<i>Time of study</i>	<i>2000</i>
Character of study	Quantitative
No. of companies participating	50
Type of industry	Mining, steel, paper, rubber, plastic, chemical, dairy
Number of respondents	50
No. of employees in average	50–1000
Unit of analysis	Product development work

Due to the character of the research (the amount of respondents), telephone interviews were considered to be best at this stage of the research to explore how process industries view their development today and in the future. Another fact is that it is an area of little research. A semi-structured interview technique was applied with a focus on certain issues, i.e. systematisation of information. The main unit of analysis is on the product development project, but also on the company level, concerning means and tools to systematise and spread information.

Another source of information for this research has been the companies' annual reports, where the statements of the companies' strategy intentions were compared (from the year 1985 and the year 2000). Annual reports are one of the most obvious documentary data sources for longitudinal studies. They are produced by all companies at the same time every year, and are readily available. This methodology has been used in past research to assess and explain corporate strategies, to identify key areas of competition, and to explore causal reasoning within firms (Huff and Huff, 2000).

4.1 Sample

The criterion for selecting the companies to study was that they should be part of the process industry, i.e. produce a product that can be further value-added in the next stage of the value-chain (e.g. by customers in their production process). However, due to the scarcity of available companies in the selected industries, the total number of companies is quite low. A sample of companies was taken from branch organisations. Companies were initially contacted by telephone to ensure that they were involved in development projects, to identify the key respondents, and to solicit cooperation. Out of 55 companies, 50 agreed to participate in the research. To ensure reasonable reliability of the data, respondents received a copy of their answers to the questions where they could make alterations, etc. Altogether, 50 companies participated with one respondent from each company. Since the purpose of the study was to investigate current development work,

changes during the 1990s, and future needs into development projects, the respondents needed to have deep insights into development work. Therefore, most of the respondents were R&D managers while in smaller companies some were project leaders or members of a product development project. Table 2 gives the distribution of the companies for each sector and their size. The companies are divided into three groups: small, medium, and large, depending on the number of employees.

Table 2 Number of companies in sample by type of industry, size and product

<i>Type of industry</i>	<i>Size of the company</i>			<i>Type of product</i>		
	<i>Small (no. employees <100)</i>	<i>Medium (100 ≤ no. employees <500)</i>	<i>Large (no. employees ≥500)</i>	<i>High- volume</i>	<i>Niche</i>	<i>Mixed</i>
Ore	0	0	2	2	0	0
Steel	0	1	8	1	4	4
Paper	0	0	7	2	2	3
Chemicals	6	6	3	5	5	5
Rubber	1	2	3	0	5	1
Plastics	2	2	0	0	4	0
Food/dairy	0	1	6	0	1	6
Total	9	12	29	10	21	19

The study also compares the 50 companies' strategies (i.e. the Groups' strategies) from the seven process industries over a 15-year period (based on an analysis of annual reports from 1985 and 2000), i.e. the analysis is based on if the companies have changed their statement concerning their strategic intention of development work (what was regarded as important in the respective year and what was the main focus). Key terms, like product development, higher margins, value-added products, and customer need, were searched for in the strategy statements from 1985 and 2000. There is an indication of a changed strategy if the company emphasises some of these key terms in the year 2000, but not in the year 1985.

Data was gathered from structured telephone interviews with open-ended questions, enabling a rich understanding of the companies' current development work that could be used to explain a certain phenomenon. The majority of interviews were recorded and typed (due to certain circumstances, two interviews were not recorded, but were typed). All interview materials were then coded with a software technique called 'Non-numerical Unstructured Data Indexing Searching and Theorising' (N5), a computer package designed to aid users in handling non-numerical and unstructured data in qualitative analysis. The texts were first coded with nodes and organised into a 'tree' structure, enabling thorough qualitative analyses of the material concerning, e.g. future needs in concerning development. The material (the hypotheses) was then tested to investigate if there was a relationship between the variables: strategic change, the use/need of information technologies (i.e. databases in development projects) and the view of networks in development.

5 Analysis and results

This research project tests the hypothesis that upstream companies in process industries that have changed perspective in development have also invested in and used IT (e.g. databases) and are aware of the importance of building suitable networks to support development work. Further, what role does IT play in a change of direction from process-oriented development to product-oriented development for traditional upstream process industries?

5.1 Position in the supply value chain

To test the hypothesis, the 50 companies were first divided into two groups as per the traditional characteristics for 'upstream vs. downstream company', according to Galbraith's categorisation in the supply chain (Galbraith and Kazanjian, 1986). The companies' product types in 1985 determine the categorisation, based on Galbraith's spectrum of product characteristics (the degree of value-added) combined with stated development intentions in 1985.

So, is there any difference between upstream vs. downstream companies when it concerns the use of information systematisation and networking? Table 3 shows the distribution of the companies in the upstream vs. downstream category. According to their product type in 1985, 28 companies are classified as upstream and 22 as downstream.

Table 3 Number of companies in sample by type of industry and number of upstream vs. downstream companies (divided after the companies' product type in 1985)

<i>Type of industry</i>	<i>Position in the supply value chain</i>	
	<i>Upstream</i>	<i>Downstream</i>
Ore	2	0
Steel	7	2
Paper	4	3
Chemicals	9	6
Rubber	2	4
Plastics	0	4
Food/dairy	4	3
Total	28	22

5.2 Cross-tabulation and chi-square test

To test if there is a relationship between the variables strategic change for Swedish process industries, the use of systematisation of information and networking, the following section presents a cross-tabulation table and a chi-square test with nominal variables. The tested variables are the following;

- position in the supply value chain (according to upstream vs. downstream characteristic)
- changed strategy towards customer/product focus during the 1990s (comparison between the year 1985 and 2000)

- the use of information technologies in development projects (all types of means to systematised information)
- networking (i.e. collaboration with institutions, universities, and actors with needed competence).

The first step is to investigate if there is a difference between upstream vs. downstream companies concerning a changed strategy. The cross-tabulation, Table 4, shows the frequency of each response at each company concerning the variable upstream or downstream company and the change of strategy towards value-adding (customer focus). The total sample of companies is 50, but there is no record of strategic intentions for five of them (i.e. there were no annual reports to compare), so the total number of companies in this analysis are 45.

Table 4 The frequency of the position in the supply value chain and changed strategy

<i>Position in the supply value chain in 2000</i>	<i>Changed strategy towards customer/value-adding</i>			<i>Total</i>
	<i>Changed</i>	<i>Had already customer focus in 1985</i>	<i>No change</i>	
Upstream	17	9	1	27
Downstream	4	13	1	18
Total	21	22	2	45
Phi=0.447 Sign.=0.019				

Table 4 shows that a majority of upstream companies have changed their strategy during the 1990s (17 of 27 companies) and that the majority of downstream companies had already a customer-focused strategy in 1985 (13 of 18 companies). All except two companies in the year 2000 had customer-focused strategy. To analyse if there in fact is a difference, a chi-squared test is done.

The two-sided asymptotic significance of the chi-square statistic is less than 0.05 (sign.=0,019), indicating a difference between the two groups (Table 4). However, a chi-square test is useful for determining if there is a relationship, not the strength of the relationship.

The second step is to investigate the relationship between the position in the supply value chain (upstream vs. downstream companies) and the use of information systematisation and networking. The result shows that 64% of the upstream companies (18 companies) use some type of systematisation of information in development projects and 41% of the downstream companies (nine companies). Of the upstream companies, 57% (16 companies) declare the importance of working in networks concerning development today and only 18% of the downstream companies (four companies) (Table 5). (Since there is no record for five of the companies concerning their strategy, the total number of companies in the left column is 45 instead of 50).

Table 5 The frequency of the variables position in the supply value chain, strategy in 2000, systematisation of information and networking (customer-oriented strategy – CO)

<i>Position in the supply value chain</i>	<i>Strategy in the year 2000</i>		<i>Systematisation of information in 2000</i>		<i>(View of) networking in 2000</i>		<i>Total</i>
	<i>CO</i>	<i>No CO</i>	<i>Yes</i>	<i>No</i>	<i>Yes</i>	<i>No</i>	
Upstream	26	1	18	10	16	12	28
Downstream	17	1	9	13	4	18	22
Total	43	2	27	23	20	30	50
Phi	0.044		0.233		0.395		
Sign. V.	0.768		0.100		0.005		

The results show that all types of companies (both ‘upstreamers’ and ‘downstreamers’) seem to apply the same strategy today, i.e. a customer-oriented strategy (CO). But an interesting result is the fact that more upstream than downstream companies emphasise the importance of systematisation of information and networking. The two-sided asymptotic significance of the chi-square statistic concerning position in the supply value chain and networking is less than 0.05 (the significance value shows 0.005), indicating a difference between the two groups (Table 5). Hence, there is indication that upstream companies are more aware of the importance of collaboration in networks in development than downstream companies. However, for the variable systematisation of information, the significance value showed 0.100, i.e. no significant difference between the upstream vs. downstream companies. Can this difference be explained by the fact that more upstream than downstream companies have changed their strategy towards customer-orientation during the 1990s? Tables 6 and 7 show no difference between those who already had a customer-oriented strategy in 1985 and those who have changed strategy during the 1990s.

The difference between upstream and downstream companies concerns those who do not have systematisation of information and do not view networking as particularly important. This difference is because there are more upstream companies that have changed their strategy than downstream companies. The significance test values for the two types of companies regarding changed strategy or not are 0.006 for upstream and 0.027 for downstream (Tables 6 and 7).

So, what does this analysis tell us? The results indicate that the gap between upstream and downstream companies is closing, i.e. upstream companies have changed their strategy towards a more customer-oriented strategy. The results also indicate that upstream companies are more aware of the importance of working in networks today. However, the analysis does not state if there is a relationship between ‘a changed strategy’ and the two variables ‘systematisation of information’ and ‘networking’, though there is a difference between ‘upstreamer’ and ‘downstreamer’ considering networking.

Is there also a difference between upstream and downstream companies regarding a future investment need in systematisation of information and networking? Table 8 indicates no difference between the two groups, i.e. upstream vs. downstream companies. However, collaboration with customers and the awareness of utilising new competences and knowledge in development projects are two major needs regarded as important in the future. (‘Other needs’ in the future can, for example, be continuous change, decrease cost.)

The impact of supply chain information

141

Table 6 Cross-tabulation of the variables; position in the supply value chain, changed strategy, and use information systematisation

<i>Systematisation of information</i>	<i>Position in the supply value chain in 2000</i>	<i>Changed strategy between 1985 and 2000</i>		<i>Total</i>	<i>Phi (Sign.)</i>
		<i>Changed strategy</i>	<i>Not changed</i>		
Yes	Upstream	9	9	18	0.327 (0.102)
	Downstream	1	6	7	
	Total	10	15	25	
No	Upstream	8	1	9	0.616 (0.006)
	Downstream	3	8	11	
	Total	11	9	20	

Table 7 Cross-tabulation of the variables; position in the supply value chain, changed strategy, and networking

<i>Networking</i>	<i>Position in the supply value chain in 2000</i>	<i>Changed strategy between 1985 and 2000</i>		<i>Total</i>	<i>Phi (Sign.)</i>
		<i>Changed strategy</i>	<i>Not changed</i>		
Yes	Upstream	9	6	15	0.387 (0.110)
	Downstream	0	2	2	
	Total	9	8	17	
No	Upstream	8	4	12	0.417 (0.027)
	Downstream	4	12	16	
	Total	12	16	28	

Table 8 Needs concerning changes in the future

<i>Position in the value chain</i>	<i>Future needs</i>						<i>Total</i>
	<i>Customer info/ collaboration</i>	<i>Supplier collaboration</i>	<i>Information systematisation</i>	<i>Use new competence/ knowledge</i>	<i>Networks</i>	<i>Other needs</i>	
Upstream	7	0	2	6	2	11	28
Downstream	5	1	3	4	1	8	22
Total	12	1	5	10	3	5	50

5.3 ‘Supply chain information’ in product development work

But what type of information is required today in product development work? An illustration of some of the quotes (expressed by some of the respondents) of what kinds of information steel and food and dairy companies require in development follows below. The industries and companies are chosen because they give good illustrations from upstream companies on the changing needs of supply chain information in development projects, followed by a changed need of networking. The quotes indicate that information concerning the entire supply chain is needed today in product development and a way to support this information need is through networking and other relationships.

5.3.1 Steel industry

- “An important component in development work is technical market support, which comes from input about trends and customers’ demands. In development, teams work very closely with equipment suppliers. Networking with suppliers, which is more formal, has increased. It is important to have the customer presence’, possibly through the sales team with qualified technicians, i.e. part of the marketing organisation.”
- “It is important that end-users are involved in development.”
- “Product development is generally about adjusting the product to fit the customers’ process and product.”
- “Development must cover a larger part of today’s value chain and realise what gives customer value.”
- “Development should be more observant and sensitive so as to grasp the market signals.”
- “Today, development needs information concerning the customers or further down the chain (end-users).”

5.3.2 Food and dairy industry

- “Ideas come from customers while development conducts the preliminary work, i.e. to get it right from the beginning. The product must fit the customers’ processes.”
- “Development covers a large part of the current value chain. Those who work with development must have contact with the customers because development needs to incorporate new ideas and knowledge into projects.”
- “Viewing trends early is vital; something that product functionality demands more of today. Also, in development today, knowing how a product’s material properties are transformed in both the customers’ processes and products is another important aspect. Obtaining information from the entire product chain is vital, from raw material to packaging and transportation, along with knowing how customers will use the product.”
- “Working in networks is essential because of the important knowledge possessed by raw material suppliers. Networking is relatively new to the company, but it is an important means of incorporating competence when development demands it. Development has closer contact with suppliers than before by being able to meet and discuss trends and possible new products.”

6 Discussion of results

The purpose of this paper is to investigate the change of development focus for Swedish process industries and the impact this change has had on the use of information technologies and networking.

The results showed that upstream companies are more aware of the importance of using some type of means to systematise information in development projects, and they also view networking as important compared to downstream companies. Why? One might expect that companies that have had a longer customer-oriented strategy also have a tradition of systematising information and working in networks. However, the results do not support Dewett and Jones (2001), who state that IT must be tightly coupled with strategy because IT affects strategy and strategies have IT implications. The results indicate no connection to a change of strategy and the utilisation of some means to systematise information. As well, IT does not play a major role concerning a changed strategy of development focus for the companies in this study. But, the results in this study can give certain indications concerning the Swedish process industry.

To answer the question 'Why upstream companies are more aware of the importance to systematise information and to work in networks in development work?' the results must be viewed together with some of the respondents' statements (quotes).

Much development work today requires more and deeper collaboration with customers due to the need of 'reading market signals'. There is an indication of a trend to integrate forward in the supply value chain, i.e. to be a development partner to customers, to take more responsibility for customers' development work for process industries. One way to choose for process industries concerning development is to stay focused on economies-of-scale, i.e. keep the cost low and produce a high-volume product. This is, however, difficult for Swedish companies, who generally have high costs (e.g. personnel and production processes). Another way is to develop niche products (specific products), with special properties or a combination of product and service concepts. If a company cannot develop the physical product, it might then develop a service attached to the product. But it requires a change in finding and building sustainable relationships with suppliers and customers. Implications of this change are that companies in the process industry must work more structurally and systematically with sources of information.

The study indicates that if a company cannot develop a product's properties any further, then other aspects can be attached to the development work, e.g. development of a service combined with the product or development of customers' production processes. This also requires more focus on systematisation of information and especially networking. One factor that makes upstream companies more aware of the need of systematisation of information and networking can be that it is difficult for them to involve, for example, end-users in product development, so they need to formalise the linkages to secure the information from them.

However, the study also indicates that a means to systematise information in an appropriate way is still lacking. Information concerning product development in process industries is more complex today than it was two decades ago. Other aspects need to be considered in product development projects today. Aspects in dairy products (like milk) can be properties connected to health or convenience. For example, the package must be easy to carry and open. Another aspect can be product adjustment according to the various parameters in the customers' production processes. The amount of information needed in projects has increased. Development projects need information from various

sources today, i.e. customer information, production data (from customers' processes and the company's own process), and product information (parameters and properties). Sales personnel possess a great deal of information about the customers' needs, but transferring the information to development projects is difficult. Therefore, to facilitate information collection, distribution, and spreading, a mutual database linking several information sources can be effective to constitute formalised information links (Figure 3), i.e. IT can act as a coordinator of activities. These links can run from centralised R&D functions, customers, and suppliers. This figure only depicts how a mutual database (or other means of information systematisation) can be the link to some actors in product development projects. The R&D function symbolises a central unit of research.

Figure 3 Formalised linkages to database in product development work

It will be essential for Swedish companies in the future to systematically gather and distribute information to enable effective development work. A database is one means to achieve this effectiveness. However, it requires resources and can take 2 to 3 years to yield any benefits. An important issue in the future is to penetrate problems at the customers' location and be able to solve them rapidly, requiring a focus on networking and building sustainable webs of information sources. Much network building depends on the individual themselves in the development team. But it is vital that the company has a clear strategy concerning the importance and possible links to both suppliers and customers.

Today, technical changes are happening rapidly; therefore it is great importance for companies to find and build sustainable relationship with suppliers of equipment and processes. Network activities in development are increasing for all process industries. In many cases, companies view their suppliers as an integrated part of their own product flow process. Research (Bensaou, 1997) shows that information technology can be a significant determinant of cooperation.

7 Conclusions

There has been and there will be considerable changes for Swedish process industries. The purpose of this paper has been to investigate some impacts of the change of focus in development for process industries. The role IT plays concerning a change of direction

to customer-focused development cannot be stated with this research. However, does IT create a need of enhanced collaboration and networking or does the need of collaboration and networking create a need of IT?

Has the need of 'new' information changed the network structure to both suppliers and customers within process industry? Yes, it has changed. There is an increased need to build sustainable links to both customers/suppliers and institutions/universities to incorporate new competence/knowledge. But to facilitate these linkages a formal facilitator is needed so that customer-value can be 'built' into the development work, i.e. incorporated in development projects. But as Scott (2000) emphasises, management needs to create a culture that knows how to exploit IT.

Today, the dilemma for process industries is that much development work requires personal contacts with customers without having suitable information technologies that support that linkage. To reach a market-oriented perspective in development, management should, early in the process of strategy change, emphasise evaluation of needed networks and IT systems to make the development process more efficient.

So, the role of R&D is about to change for process industries. It is more about collaboration and networking today to acquire new competences and knowledge into development projects. This study presented in this paper has merely scratched the surface of the dilemma of conducting product development work in process industries. There is a need of deeper research in many areas concerning how to integrate actors into a suitable network, and what means are appropriate to systematise information.

In sum, knowing what gives value in your supply chain can facilitate;

- identification of vital information sources
- what information to collect (both from suppliers and customers)
- building suitable networks.

References

- Araujo, L., Dubois, A. and Gadde, L. (1999) 'Managing interfaces with supplier', *Industrial Marketing Management*, Vol. 28, No. 5, pp.497–506.
- Bailetti, A.J. and Litva, P.F. (1995) 'Integrating customer requirements into product designs', *Journal of Product Innovation Management*, Vol. 12, pp.3–15.
- Balachandra, R. and Friar, F.H. (1997) 'Factors for success in R&D projects and new product innovation: a contextual framework', *IEEE Transactions on Engineering Management*, Vol. 44, No. 3, pp.276–287.
- Barut, M., Faisst, W. and Kanet, J.J. (2002) 'Measuring supply chain coupling: an information system perspective', *European Journal of Purchasing and Supply Management*, Vol. 8, No. 3, pp.161–171.
- Bechtel, C. and Jayaram, J. (1997) 'Supply chain management: a strategic perspective', *The International Journal of Logistics Management*, Vol. 8, No. 1, pp.15–34.
- Bensaou, M. (1997) 'Interorganizational cooperation: the role of information technology. An empirical comparison of US and Japanese supplier relations', *Information Systems Research*, Vol. 8, No. 3, pp.107–124.
- Bondra, J.C. and Davis, T.R.V. (1996) 'Marketing's role in cross-functional information management', *Industrial Marketing Management*, Vol. 25, No. 3, pp.187–195.

146 D. Chronéer

- Bruce, M., Leverick, F., Littler, D. and Wilson, D. (1995) 'Success factors for collaborative product development: a study of suppliers of information and communication technology', *R&D Management*, Vol. 25, No. 1, pp.33–44.
- Butscher, S. and Laker, M. (2000) 'Market-driven product development', *Marketing Management*, Vol. 9, No. 2, pp.48–53.
- Campbell, A.J. and Cooper, R.G. (1999) 'Do customer partnerships improve new product success rates?', *Industrial Marketing Management*, Vol. 28, pp.507–519.
- Christopher, M. (1998) *Logistics and Supply Chain Management: Strategies for Reducing Cost and Improving Service*, London: Pitman Publishing.
- Chronéer, D. (2003) 'Have process industries shifted their centre of gravity during the 90s?', *International Journal of Innovation Management*, Vol. 7, No. 1, pp.95–129.
- Comer, J.M. and Zirger, B.J. (1997) 'Building a supplier-customer relationship using joint new product development', *Industrial Marketing Management*, Vol. 26, pp.203–211.
- Danneels, E. (2002) 'The dynamics of product innovation and firm competences', *Strategic Management Journal*, Vol. 23, No. 1, pp.1095–1121.
- Dewett, T. and Jones, G.R. (2001) 'The role of information technology in the organization: a review, model, and assessment', *Journal of Management*, Vol. 27, No. 3, pp.313–346.
- Docherty, P. and Stymne, B. (1995) 'Mediators of IT-effectiveness', *Working Paper*, Göteborg: IMIT.
- Dwivedi, S.N. and Sharma, J.P. (2002) 'Role of customers in the development of innovative process and product', *International Journal of Computer Applications in Technology*, Vol. 15, Nos. 1–3, pp.24–36.
- Etienne, E.C. (1981) 'Interactions between product R&D and process technology', *Research Management*, January, pp.22–27.
- Fischer, R.J., Maltz, E. and Jaworski, B.J. (1997) 'Enhancing communication between marketing and engineering: the moderating role of relative functional identification', *Journal of Marketing*, Vol. 61, No. 3, pp.54–70.
- Flint, D.J. (2002) 'Compressing new product success-to-success cycle time. Deep customer value understanding and idea generation', *Industrial Marketing Management*, Vol. 31, pp.305–315.
- Galbraith, J.R. and Kazanjian, R.K. (1986) *Strategy Implementation. Structure, Systems and Process*, St. Paul: West Publishing Company.
- Griffin, A. and Hauser, J.R. (1993) 'The voice of the customer', *Marketing Science*, Vol. 12, No. 1, pp.1–27.
- Griffin, A. and Hauser, J.R. (1996) 'Integrating R&D and marketing: a review and analysis of the literature', *Journal of Product Innovation Management*, Vol. 13, pp.191–215.
- Gruner, K.E. and Homburg, C. (2000) 'Does customer interaction enhance new product success?', *Journal of Business Research*, Vol. 49, pp.1–14.
- Gunasekaran, A. and Nath, B. (1997) 'The role of information technology in business process reengineering', *International Journal of Production Economics*, Vol. 50, pp.91–104.
- Guy, Dr. K.W.A. and Eng, F. (1994) 'The industrial challenge: the process industries in the 21st century', *Proceedings of the 4th European Symposium on Computer Aided Process Engineering*, Dublin, Ireland, 28–30 March, pp.479–480.
- Håkansson, H. (1990) 'Product development in networks', in: D. Ford (Ed.) *Understanding Business Markets: Interaction, Relationships and Networks*, London: Academic Press, pp.487–507.
- Håkansson, H. and Ford, D. (2002) 'How should companies interact in business networks?', *Journal of Business Research*, Vol. 55, pp.133–139.
- Harkins, J.R. and Dubreuil, M.P. (1993) 'Concurrent engineering in product design/development', *Plastics Engineering*, Vol. 49, August, pp.27–31.

- Hartley, J.L., Meredith, J.R., McCutcheon, D. and Kamath, R.R. (1997) 'Suppliers' contribution to product development: an exploratory study', *IEEE Transactions on Engineering Management*, Vol. 44, No. 3, pp.258–266.
- Huff, A.S. and Huff, J.O. (2000) *When Firms Change Direction*, New York: Oxford University Press.
- Ita, P.A. and Gross, A.C. (1995) 'Industry corner: world rubber and tire', *Business Economics*, Vol. 30, No. 1, pp.58–63.
- Jarvenpaa, S.L. and Ives, B. (1994) 'The global network organization of the future: Information management opportunities and challenges', *Journal of Management Information Systems*, Vol. 10, No. 4, pp.25–57.
- Jones, T. (2002) *Innovating at the Edge: How Organizations Evolve and Embed Innovation Capability*, Oxford: Butterworth-Heinemann.
- Kahn, K.B. (2001) 'Market orientation, interdepartmental integration, and product development performance', *Journal of Product Innovation Management*, Vol. 18, pp.314–323.
- Kahn, K.B. and McDonough III, E.F. (1997) 'An empirical study of the relationships among co-location, integration, performance, and satisfaction', *Journal of Product Innovation Management*, Vol. 14, pp.161–178.
- Kärkkäinen, H., Piippo, P. and Tuominen, M. (2001) 'Ten tools for customer-driven development in industrial companies', *International Journal of Production Economics*, Vol. 69, pp.161–176.
- Krause, D.R. and Scannell, T.V. (2002) 'Supplier development practices: product- and service-based industry comparisons', *The Journal of Supply Chain Management*, Spring, pp.13–21.
- Lager, T. (2002) 'Product and process development intensity in process industry: a conceptual and empirical analysis of the allocation of company resources for the development of process technology', *International Journal of Innovation Management*, Vol. 6, No. 2, pp.105–130.
- Lambert, D., Cooper, M. and Pagh, J. (1998) 'Supply chain management: implementation issues and research opportunities', *The International Journal of Logistics Management*, Vol. 9, No. 2, pp.1–18.
- Levary, R.R. (2000) 'Better supply chains through information technology', *Industrial Management*, Vol. 42, No. 3, pp.24–30.
- Lipnack, J. and Stamps, J. (1997) *The Age of Networks*, New York: John Wiley & Sons Ltd.
- Littler, D. and Leverick, F. (1995) 'Joint ventures for product development: learning from experience', *Long Range Planning*, Vol. 28, No. 3, pp.58–67.
- Magrath, A.J. and Hardy, K.G. (1994) 'Building customer partnerships', *Business Horizons*, Vol. 37, No. 1, pp.24–27.
- Mello, S. (2001) 'Right process, right product', *Research Technology Management*, Vol. 44, No. 1, pp.52–58.
- Olson, E.M., Walker, Jr. O.C., Ruekert R.W. and Bonner, J.M. (2001) 'Patterns of cooperation during new product development among marketing, operations and R&D: implications for project performance', *Journal of Production Innovation Management*, Vol. 18, pp.258–271.
- Ottum, B.D. and Moore, W.L. (1997) 'The role of market information in new product success/failure', *Journal of Product Innovation Management*, Vol. 14, pp.258–273.
- Patti, A.L., Gilbert, J.P. and Hartman, S. (1997) 'Physical co-location and the success of new product development projects', *Engineering Management Journal*, Vol. 9, No. 3, pp.31–37.
- Persson, U., (1997) 'A conceptual and empirical examination of the management concept supply chain management', *Lic. Thesis*, Division of Industrial Logistic, Luleå University of Technology, Sweden, p.29.
- Pick, P. (1999) 'Building customer – supplier relationship in electronics', *Long Range Planning*, Vol. 32, No. 2, pp.263–272.

- Ragatz, G.L., Handfield, R.B. and Scannell, T.V. (1997) 'Success factors for integrating suppliers into new product development', *Journal of Product Innovation and Management*, Vol. 14, pp.190–202.
- Rycroft, R.W. and Kash, D.E. (1999) 'Managing complex networks – key to 21st century innovation success', *Research Technology Management*, May–June, pp.13–18.
- Schary, P.B. and Skjøtt-Larsen, T. (1995) *Managing the Global Supply Chain*, Denmark: Handelshøjskolens forlag.
- Scott, J.E. (2000) 'Facilitating interorganizational learning with information technology', *Journal of Management Information Systems*, Vol. 17, No. 2, pp.81–113.
- Simchi-Levi, D., Kaminsky, P. and Simchi-Levi, E. (2003) *Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies*, 2nd edn., New York: McGraw-Hill.
- Slater, S.F. and Narver, J.C. (1998) 'Customer-led and market-oriented: let's not confuse the two', *Strategic Management Journal*, Vol. 19, pp.1001–1008.
- Song, X.M., Montoya-Weiss, M.M. and Schmidt, J.B. (1997) 'Antecedents and consequences of cross-functional cooperation: a comparison of R&D, manufacturing, and marketing perspectives', *Journal of Product Innovation Management*, Vol. 14, pp.35–47.
- Song, X.M., Neeley, S.M. and Zhao, Y. (1996) 'Managing R&D-marketing integration in the new product development process', *Industrial Marketing Management*, Vol. 25, No. 6, pp.545–553.
- Song, X.M., Thieme R.J. and Xie, J. (1998) 'The impact of cross-functional joint involvement across product development stages: an exploratory study', *Journal of Product Innovation Management*, Vol. 15, pp.289–303.
- Swink, M. and Mabert, V. (2000) 'Product development partnerships: balancing the need of OEMs and suppliers', *Business Horizons*, Vol. 43, No. 3, pp.59–68.
- Tatikonda, M.V. and Stock, G.N. (2003), 'Product technology transfer in the upstream supply chain', *The Journal of Product Innovation Management*, Vol. 20, No. 6, pp.444–467.
- Tottie, M. and Lager, T. (1995) 'QFD-linking the customer to the product development process as a part of the TQM concept', *R&D Management*, Vol. 25, No. 3, pp.257–267.
- Wynstra, F., van Weele, A. and Weggemann, M. (2001) 'Managing supplier involvement in product development: three critical issues', *European Management Journal*, Vol. 19, No. 2, pp.157–167.