MASTER

Collaboration in the electronics industry : perspectives on business issues, processes and software

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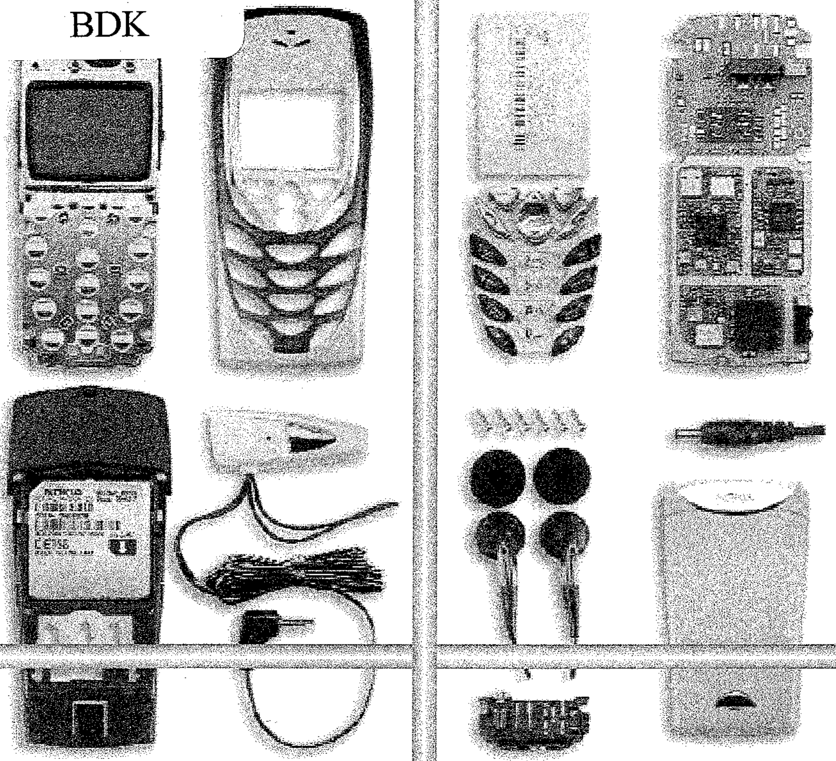
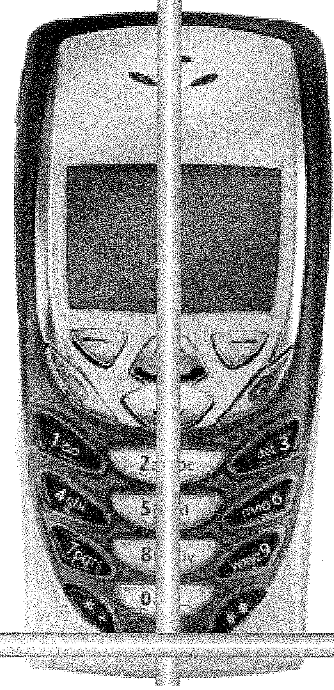


Collaboration in the Electronics Industry

Perspectives on business issues, processes and software

Hans M. Moonen



Collaboration in the Electronics Industry

Perspectives on business issues, processes and software

Master Thesis
Industrial Engineering & Management Science
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Abstract

This master-thesis describes the results of a research project conducted at Baan and Deloitte&Touche. Baan develops enterprise software for industrial companies active in several manufacturing domains, such as the Electronics industry. Due to the challenges and changes in the Electronics industry, companies start to look beyond intra-enterprise optimization. Collaboration with supply chain partners is the next logical step. This research focuses on the industry backgrounds, business strategies, supply chain management aspects, and translate this into the definition of several collaborative processes. The latter parts of this report focus at the software support for collaborative environments and apply all theory in the procurement domain. The report is concluded with suggestions for further research.

Executive summary

Driven by (industry structure) changes in the Electronics industry and the current opportunities of modern enterprise information systems, collaboration between supply chain partners becomes more common. Companies intensify their relationships, start to exchange (more) information, and try to execute processes in a shared manner. This master-thesis focuses on business issues and processes, and makes a link with enterprise software. It is the result of an internship primarily conducted at Baan Development in Barneveld, The Netherlands, and partly at the supply chain management group of Deloitte&Touche (Bakkenist) in Diemen, The Netherlands.

The research project has been initiated under the following problem definition:

How should enterprise software vendors change their software products to help companies in the Electronics industry in confronting their collaborative challenges?

The research questions have been centered around three central themes: First, it is needed to widen the knowledge and understanding of the Electronics industry, and the supply chain management field. Second, knowledge of collaborative processes is an essential element. Third, insight in the essential elements in collaborative enterprise software environments should be explored. To reach these objectives, a mixed research approach has been followed, which is partly empirical, partly case based, and partly modeling based. Literature study, domain expert input, and input from companies in the Electronics industry (Neways, Omron, Elcoteq, and Flextronics) has been used.

This report is structured in five separate parts. Part I describes the background of the project. Part II focuses on collaborative processes. Part III on collaborative software solutions, and Part IV connects all previous parts and applies the earlier collected theory to the procurement domain. Part V reviews the document and lists some research recommendations.

Part I – Background

The Electronics industry

The Electronics industry has always been an industry with its challenges. Issues such as globalization, low margins, short product lifecycles, short time-to-market, the need for customer-specific products, and last but not least the continuously decreasing prices (of parts, and end products), are around since decades already, but these issues have become more stringent over the last years. See also Chapter 1 and 3.

One of the specific issues this industry has to face is caused by the small differences between components (what leads to problems with the item numbering/versioning), and the common practice that one product can be build through different bill-of-materials (BOMs) – and still be the same end product.

The industry structured has changed over the last decades. Most companies in these supply chains now concentrate on their core-competences, typically no more than one or two processes. The non-core processes get outsourced to (specialized) partners. Many Original Equipment Manufacturers (OEMs) for example, do not manufacture that much themselves anymore, instead they now focus solely on marketing and design. The production gets outsourced to contract manufacturers, referred to as Electronics Manufacturing Services providers (EMS). Analysts expect a bright future for these EMS's, and predict high growth rates for the next years.

Not surprisingly, there is a growth in the number of inter-dependencies between the different partners in such supply chains. Furthermore, the supply chains become less linear as the used to be, and evolve into networks of interdependent companies. One of the risks of this outsourcing trend is the natural gap that exists between two (or more) companies, such as, for example, the possibility of miscommunication and inefficiencies caused by the gap between those who design, market and sell the product, and those who manufacture it.

Therefore, it is natural for companies in this industry, to sit together with their supply chain partners, and start collaborating with one-another. That can improve speed, visibility and trust in the whole supply chain, and boost its performance. To execute collaborative processes, companies need to synchronize their activities and processes, and exchange information.

Supply chain collaboration

Today, *Supply Chain Management* (SCM), as well as *Collaboration* are buzz-words; results of a hype. Analysts, enterprise software vendors, consultancy firms, and academics – everybody is speaking about it. This hype, however, is not entirely new. Many similar supply chain improvement initiatives have been tried and implemented over the last years already, such as for example Electronic Data Interchange (EDI), Vendor Managed Inventory (VMI), and Efficient Consumer Response (ECR). What

has changed, is that, over the last years costs have been minimized within corporate borders, and that the next frontier for cost minimization is cooperation or collaboration. Next to that, enterprise information systems have become more open recently, and are better suited for applications in collaborative environments.

This report uses the following definition of SCM:

> *"Supply Chain Management is defined as the systematic, strategic coordination of the traditional business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole."*

This definition shows that there is not one single area where SCM (and collaboration) lays, but that it is the collection of business functions within and across companies and businesses. For more details, see Chapter 2.

Role of strategy

There is no single best domain to start collaborative initiatives with supply chain partners. Companies use (and execute) different strategies to position themselves against their direct competitors. According to the value discipline theory, there are three different disciplines companies can specialize in: they can either try to be *operational excellent*, *product leader*, or *customer intimate*. It does not make sense to try to be all a leader in all three, since the disciplines compete. However, companies, which choose one discipline, need to maintain industry standards in the other disciplines.

EMS companies work for OEMs. Their natural role (and background) lays in operational excellence, however, they can choose to specialize in one of the other disciplines as well – under while maintaining the high industry standards of operational excellence. Production and logistics are the traditional domains for an EMS – the OEM does therefore generally outsource specifically the related functions. EMS companies that choose to become more customer intimate, are likely to focus more on the sales and service domains, which may be performed in a collaborative manner together with the OEM customer. For EMS' that thrive to become product leaders, design is an interesting area to collaborate upon with partners (suppliers and/or customers). Chapter 4 provides more information, and some examples.

Part II – Collaborative processes

Framework

A simple matrix with nine business functions on one axis, and the three different value disciplines on the other, function as the framework to identify interesting collaborative processes. The nine business functions are: marketing, research and development (R&D), forecasting, procurement, production, logistics, sales, service and finance.

The objectives to initiate collaborative design, for example, differ with the value discipline in charge. EMS companies which are operational excellent, may use it to design-for-manufacturability; which means that input from the (EMS) factory-floor is integrated in new or improved designs that are cheaper to produce. For an EMS with a product leadership focus, collaborative design shall be focused on a short time-to-market and the (continuous) introduction of new products. The collaborative execution of the design process helps in reaching these objectives.

A comparative analysis has been performed for all different functions, and integrated in the framework. See Chapter 5. Clustering different collaborative functions delivered some interesting suggestions for (future) collaborative processes.

The processes

Collaborative order fulfillment planning, for example, is a clustering of the traditional procurement, production, logistics and sales domain. It is suggested to plan all order fulfillment related decisions at the same time, since that gives a real chance to optimize everything. Production questions such as what, where, how and when to produce are handled simultaneously with delivery issues such as how and when to distribute. Optimization may take place from a cost & profit, speed, and/or customer importance perspective. Taking everything into account, the (fulfillment) network gets dynamically planned – which means that orders of a certain type, do not automatically follow a predefined route. Specifically for operational excellent or customer intimate EMS companies this concept could be valuable. However, it does not seem to be very realistic to expect this kind of solutions anytime soon. Questions, such as for example, central or decentralized planning and optimization arise. More details about the collaborative order fulfillment planning concept can be found in Chapter 7.

Other processes, which turn out to be interesting for collaboration with supply chain partners, are:

- *Collaborative design for innovative products* – Product leaders collaborate with suppliers and (OEM) customers in the marketing and R&D domain; as described earlier.

- *Collaborative design for optimal production* – Operational excellent companies perform the design (e.g. R&D) function in a collaborative manner to improve the design-for-manufacturability and design-for-testability. This is described earlier as well.
- *Collaborative planning & visibility* – Operational excellent and customer intimate companies are driven by either cheap manufacturing or customer commitments. In both cases it is important to share forecast, planning, and inventory information with supply chain partners, and to have insight in their information. The procurement and forecasting domain meet each other here. This is true for either strategic, tactical as well as operational planning decisions.
- *Collaborative customer support* – Customer intimate companies, may be triggered to focus on support to the end consumers. Information which is linked to the production process can be easily stored, and the manufacturer (EMS in this case) is the one with the expert product knowledge.

Part III – Collaborative Software

Enterprise software

As Chapter 8 shows, the first computation software and data storage became available in the 1960s. Since then, enterprise information systems have continuously evolved, and since the 1990s companies open up their systems to connect with supply chain partners. Connected via, mainly through point-to-point EDI connections. In the late 1990s, Internet connectivity became an issue, and had a major impact on (at least) the visual design of software applications.

Within one enterprise several – mostly separate – systems can be used. Enterprise Resource Planning (ERP) systems handle the core operations of the company, and do function as an enterprise backbone – mainly for operational transactions. On the buy-side, Supplier Relationship Management (SRM) systems, which are able to interact with suppliers, can be used as extensions on this backbone. The same applies for Customer Relationship Management (CRM) systems on the sell-side. Advanced Planning and Scheduling (APS) systems, are capable to oversee all company internal operations, and try to optimize everything.

Although the enterprise information system landscape looks quite advanced, diverse, well-thought, and properly integrated this is not truly the case. Input from companies in the Electronics industry – an industry which is, just like the Automotive industry, widely recognized as ahead of other industries with software implementations – delivered the insight that there is absolutely a difference between theory and practice.

Problems are, for example:
- Difficulty of (information) integration with business partners.
- Tools to enable process integration with business partners are not there.
- Visibility information (stock levels, order status, etc.) is generally lacking.
- Optimization over different links in a supply chain is hardly doable.
- Intelligent resolution processes are not present.
- Re-active responses, instead of pro-active.

Planning level influence

The insight arises that planning decisions at different planning levels request a different type of software support:
- At the *operational level*, not that much can be optimized anymore. It is only possible to make the best out of certain situations. Therefore, decisions need to be supported by functionality for exception monitoring, handling and resolution.
- At the *tactical level*, optimization between certain boundaries is still possible. Decisions therefore need to be supported by smart mathematical optimization techniques. It may be very interesting to optimize over more than only one business function – as the example of the collaborative order fulfillment planning process showed.
- At the *strategic level*, companies have the freedom to design the context (in which – in a later stage – tactical and operational decisions will be executed). Software support can come from business intelligence type of environments, and simulation tools.

Ideally, the role of enterprise information systems should be to automate optimal decision taking at the operational planning level, and to support human (intelligent) decision taking at the strategic level. Therefore, ERP systems, which are the basis of most enterprise software environments, would be a logical place for future extensions.

To automate the operational decision processes, especially in collaborative environment, an integrated layer of enterprise enabling technologies is suggested and envisioned. These four groups of technologies are: Enterprise Application Integration (EAI), Workflow Management (WFM), Supply Chain Event Management (SCEM), and Business Intelligence (BI). These technologies are currently present, but generally not integrated with one another. Integrating these technologies would provide a platform, which is capable to solve many of the problems listed above. The idea is referred to as the *Proactive Resolution Broker* concept (see also Chapter 10). It should be an environment that understands the root causes of problems, learns from its decisions, and uses human intelligence only there where it is needed. Other researchers have recently come up with similar concepts, so it might be stated that it is absolutely an interesting area for further research.

It should be useful to review the way static parameters are currently used in enterprise information systems. These parameters are set once, at implementation time, and never change anymore. In some cases it could be better to make use of – validated – historical data. See also Chapter 10.

Enterprise integration

Collaborative has everything to do with EAI. Companies need to integrate their information systems with their partners. However, not all partners are similar. Some are more strategic than others. Therefore it is logically that companies do not integrate with all partners in a similar way. Until now, much integrations go through EDI. Since EDI is only on-to-one, and requires a dedicated inflexible infrastructure, only the largest (strategic) partners are candidates for connectivity. New one-to-many (e.g. Private Trading Exchanges (PTXs)) and many-to-many (public marketplaces) initiatives make it easier to integrate with partners. XML (Extended Markup Language) technology thereby eases the integration, since it is more flexible, (generally) faster, and cheaper to implement. New XML-based standard initiatives such as Biztalk, Oagis, and RosettaNet enable integration. RosettaNet does not only define standards for the specific semantic and the technical standard, but also for the process as such.

Part IV – Close look @ Procurement

The process

Procurement is a very interesting domain for manufacturing companies in the Electronics industry. Numbers show that about 80 percent of their costs of goods sold comes from materials sourced from suppliers. Furthermore it is a domain that heavily interacts with suppliers. Procurement related optimization is possible within the own organization, but supply chain collaboration can bring even larger benefits.

Procurement is the acquisition process of goods and services from outside the production entity, directly or indirectly required to manufacture saleable goods/services. *Sourcing* – which includes procurement steps such as specify, select, and contract – is the strategic part of procurement. *Purchasing* is the operational part of procurement, and includes steps such as order, fulfillment / settlement and evaluate. See Chapter 11 for more details.

Not all procurement practices are identical. Sometimes, orders can be simply ordered against a contract (a purchase order or call-off). In other situations supplier or product selection process could be first needed, and contracts need to be arranged. Buying or ordering is really a day-to-day practice, whereas the selection of new suppliers is something that is performed perhaps only once each year. A useful division of procurement categories is the Kraljic matrix. The matrix makes a division between profit impact on one axis, and supply risk on the other. It suggests to partner (and collaborate) on i.e. the strategic category. The other categories are not that critical to a company's business, and competition mostly goes on price – collaboration with suppliers therefore is not that logical, and it is better to use the competitive market mechanisms and to procure goods from the spot market.

Chapter 12 makes clear that the procurement process is influenced by company strategies as well. Product leaders for example are likely to integrate their procurement processes with the (collaborative) design process. Operational excellent companies try to focus on low cost transactions and are likely to turn to spot markets for commodities buying. Customer intimate companies on the other hand try to focus on service, and align their procurement contracts with their own objectives in the sales domain. They request a flexible ordering process.

Procurement software

Not surprising, software to automate procurement does exist since the early days of automation. During the Internet hype years (1999-2001), e-Procurement software (i.e. Internet-enabled indirect material ordering tools) was popular and has been frequently implemented. Many of these initiatives failed, due to the single focus on (low) price-driven transactions, and lacking support for direct materials ordering. Furthermore many of these solutions were stand-alone, and not integrated with the other enterprise information systems in the organizations.

Automating operational decisions and supporting the strategic decision taking processes, would absolutely be valuable in the procurement practice. Today, much time of the (procurement) staff goes to the operational steps – buying and problem solving consumes up to 95% of their time.

At the operational level exception management becomes important. The software needs to be able to automate all regular business, and filter out the exceptions. These exceptions than get smartly handled – either through (dynamic) business rules, or through a human operator who is alerted on the emergency situation. The process for these operators should be made as easy and visible as possible

– the different options the operator has are presented, and the operator simply makes the proper choice. Which than functions as new learning material for the operational support system. Although this sounds quite practical and simple, practice shows that it is not.

In Chapter 13 a case study is presented. The case shows a situation where two companies use an ERP system, and have a (buy-sell) connection through EDI. Although these technologies could sound old-fashioned, these are still widely in use in practice (as the different meetings with companies showed). A simple analysis of this case shows that there is a collection of pain points, which hinder the ideal procurement model. These points are:

1. Inflexible exchange technology
2. Batch-wise planning processes
3. Low visibility
4. No event management

Some of these points can be overcome by the implementation of other technologies, others deal with functionality lacks in the currently available software. A real problem for example is the lacking visibility, in both the own as the supplier's current status and future capabilities. Even for companies that have strategic partnerships with their suppliers, and buy via contracts. Today, companies order without knowledge if the supplier is capable to fulfill the order. A logical first step, would be to check for availability – and perhaps even price and delivery date – before ordering, so simply execute an order promising check. Paradoxical, sales-systems generally have the functionality to do Available-to-Promise (ATP) or even Capable-to-Promise (CTP) checks, but buy-systems simply lack the functionality to initiate such checks in systems of suppliers.

Manufacturing companies in the Electronics struggle with article numbers/versions and the fact that products can be build through multiple BOMs (as was identified earlier). This struggle however can also be seen as another way to compete and to gain. It is a very interesting area for optimization. Baan was among the first vendors who recognized this, and offers a first (simple) optimization tool (iBaan MCB Optimizer) that optimizes the use of excess inventories. However, this product can be further extended. Procurement related issues such as, for example, price monitoring, quality issues, supplier relationships, possible alternatives as included in the contracts, and pro-active recommendations for alternatives (other suppliers, and/or other items) could be very interesting to include in the optimization decision. Other interesting extensions could be a coupling with a Product Lifecycle Management (PLM) system or further integration in the APS applications.

Note that procurement software solutions are more than just (technical) functionality. Especially the strategic decisions – which are not really covered in this report/research – need decision support systems with relevant content as well.

A software implementation as such can best go parallel with an organizational redesign. Not only does the new software change the way the company works, it can be used as well to streamline the processes (in which the software then supports).

Part V – The end or the Beginning

Intentionally this report has been written for Baan and Deloitte&Touche, but it can be used by industry (Electronics) and Academia as well. It gives an introduction to the different subjects and business issues, describes a way to look at supply chain collaboration and the corresponding processes, and makes a translation towards enterprise software solutions. Everything than is evaluated and concretized in the procurement domain, which turns out to be an interesting area for further improvements.

The research questions – which can be found in Chapter 1 – this project started with, have been answered largely. It turned out that the basis for a good understanding of enterprise software really lays in a thorough analysis of the business issues in a specific industry.

Some suggestions for further research can be found in Chapter 15. These research questions center around two themes: business model related or information technology related research.

Preface

This report is the result of the graduation project that I did from December 2001 to November 2002, at Baan Development in Barneveld, The Netherlands. This project, in which Deloitte&Touche (Bakkenist) participated as well, concludes my masters' study in Industrial Engineering & Management Science (in Dutch: Technische Bedrijfskunde) at Eindhoven University of Technology.

The last two years I have been involved with Baan more-or-less permanently. It started with a five months international internship in the Quebec City, Canada office in September 2000. Back in The Netherlands, I joined the team in Barneveld, and was employed – on a three days a week basis – for a couple of months, as a Jr. Product Consultant in the Solutions team.

Doing my graduation work at Baan as well, had its advantages and disadvantages. Of course, it was the same environment again; same company, same people, same culture, same problems, same industry, etcetera. On the other hand, it gave me a headstart into the project and organization, and the opportunity to work on the delivery of some results.

I can look back at a great project. It was a marvelous time, a wonderful opportunity, and a great learning experience, from different standpoints. It was interesting and challenging at the same time, to work with so many different people from both Baan and Deloitte&Touche. Another attractive side of the project was the chance I had to get in touch with customers. Although this turned out to be harder than expected, I did have the chance to get inside information from Neways, Omron, Flextronics and Elcoteq. Next to that, I had the chance to write my first conference paper [89], which got accepted, and has been presented this September.

Although it was sometimes difficult to manage the large number of coaches (six), and two companies, in my project, it was very useful as well. This situation gave me the chance to widen my view, and to have a look in all different 'kitchens'. A very special (and not requested) look in the kitchen I got this summer, during the reorganization troubles Baan went through.

Since my start in Barneveld (in April 2001) I have shared an office with Ingrid de Gier, Sipke Baarsma and Bart Dekkers. Three very special colleagues, who were always in for discussion, feedback or small talk – either in the office, in the snow in Austria, on the water, or behind the barbeque. Thanks for all the days we shared together.

Furthermore, a special word of thanks goes to Hans Wortmann and Amar Ramudhin. First, they gave me the chance to go to Quebec. Later, they and Luuk Kornelius convinced me to continue at Baan for a longer time. Thanks for your trust and inspiration.

Related to this particular end result, I would like to thank everyone who contributed, and in particular my coaches: Piet van der Vlist and Graham Sharman, from Eindhoven University of Technology; Johan Versendaal, Bart Dekkers, and Luuk Kornelius, from Baan; and last but not least Fred Tusveld from Deloitte&Touche.

Next to that, a thanks goes to the Baan and Deloitte&Touche organizations: for giving me the chance to do this graduation work. Furthermore a thanks goes to the earlier listed customers, and their account managers – they gave me useful (market) reflection and feedback. Persons that I have not mentioned so far, but who I would like to thank personally, are: Arian Zwegers, Roel van den Berg, Hans Verhoef, Arsenin Rodrigues, Ronald Teijken, Daan Snijders, John McCabe, Mart de Visser, Jeroen de Haas, and Jennifer Daniels.

Hans Moonen,

November 2002, Barneveld, The Netherlands

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List of Figures and Tables

About this document

This report is written on the assumption that the reader has basic prerequisite knowledge of the supply chain management (SCM), and enterprise information systems domains. If the reader does not have this knowledge, the report could be more difficult to read and understand.

The following aspects can be found in the report:

- Analysis of the Electronics industry; captured through literature, experts and input from companies (Chapters 1, and 3)
- Background information on SCM and competitive strategies (Chapters 1, 2 and 4)
- Framework to identify collaborative process areas (Chapter 5, and 6)
- Basic description of different collaborative processes (Chapter 7)
- Analysis of today's enterprise information systems, and i.e. enterprise application integration technologies (Chapter 8, and 9)
- The Proactive Resolution Broker concept: a suggested layer of inter-connected enterprise enabling technologies to improve operational planning issues in enterprise software environments (Chapter 10)
- Description of the procurement domain (Chapter 11), and theory how to position procurement in collaborative environments (Chapter 12)
- Concrete software recommendations for the iBaan SRM roadmap (Chapter 13)
- An overview of issues that could be interesting for further research (Chapter 15)

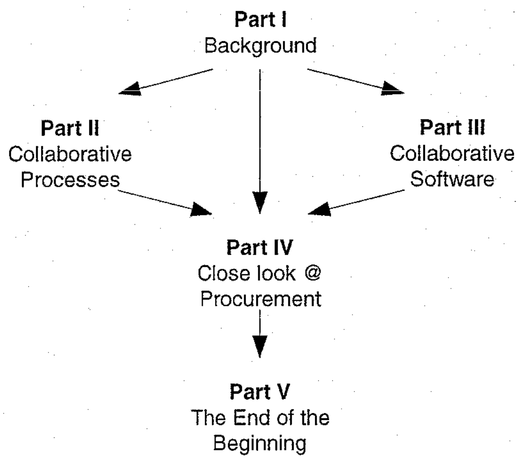
The following aspects have been left out, for different reasons, and cannot be found in the report:

- A description of the Baan and Deloitte&Touche organizations. For detailed information is referred to [u3] and [u10]
- Many models in the report have been adopted from literature. Some have been slightly adjusted for use in the context of this report. The detailed explanation is generally lacking.
- Case descriptions of the (industry-) meetings with companies. Their input is used and integrated in the report
- A comparison with other industries (such as the Automotive industry)
- Detailed evaluation of the different collaborative processes
- Detailed software analysis and recommendations. Some high-level recommendations are given. These can function as the basis for more detailed analysis
- No concrete insight in the development costs for the suggested software solutions, i.e. the Proactive Resolution Broker concept

Note that an earlier version of this report has been used as the basis for a conference paper [89], which has been presented in September 2002, at the conference on Advanced Production Management Systems in Eindhoven, The Netherlands.

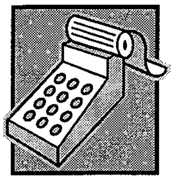
Report structure

The chapters in the report have been grouped in five different parts. These parts are interconnected as shown below:



This report has been structured in a way to save 'the professional' time. It has been split in five separate parts, and each chapter has its own summary that briefly shows the contents of the whole chapter. Figures are used for illustration purposes, and explain and support the text. References are used whenever relevant, and can be found in the reference list, which is part of the Appendix. Furthermore the document contains a list of figures and tables, and a list of abbreviations. These abbreviations are written in full length, every first time that they are used in a chapter.

Target groups

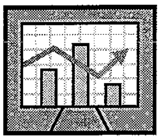


Enterprise software professional

For software professionals it can be useful to get a feeling for the industry issues as described mainly in Part I, and II of this report. Part III has a great relevance, since it directly combines business issues with software – taking today's status as the starting point. Part IV is i.e. relevant for those active in the Procurement domain. The research recommendations as done in Part V may be useful as well.

Although the report might not lead instantaneously to new software solutions, it is an essential element to get insight in collaborative environments, its problems and challenges. Collaboration is the next frontier for enterprise software. This document could play a role in vision development.

Recommended chapters: Executive summary, 8, 9, 10, 12, 13, 15

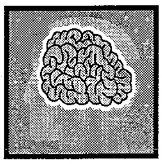


Consultant

Consultants can use the report to widen their knowledge and insights on the Electronics industry, business strategies, SCM and collaboration, collaborative processes, and enterprise software support. Especially Part I, II and III could be interesting.

It can function as an instrument to get a headstart into the different disciplines.

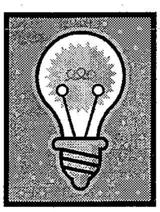
Recommended chapters: Executive summary, 3, 4, 7, 8, 9, 10, 12



Research professional

This report may be interesting for researchers in Academia and/or industry. The industry reflection, the focus on collaborative environments, and the link with enterprise software solutions may be useful material (Part I, II and III). The link with Procurement in Part IV could be interesting as well, and the same applies for the recommendations for further research in Part V. The long list of references may be of value also.

Recommended chapters: Executive summary, 1, 2, 5, 6, 7, 8, 11, 12, 15



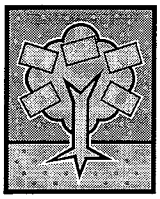
Student

Students can use this report as a quick introduction to the Electronics industry, the area of SCM and collaboration, collaborative business processes, enterprise software solutions, and the Procurement domain.

The entire report (Part I, II, III, IV, and V) can be useful material. Furthermore, it could be interesting material for the student's own research, or, to use it for example, in an internship or graduation project.

Recommended chapters: Executive summary, 1, 2, 3, 4, 8, 9, 11, 15

Part I – Background



Part I – Background

The topics covered in this Part I are diverse, but are the foundation for the rest of the report. It gives an introduction to the subjects, which play a role in the later parts of the report.

The issues covered include: background information on supply chain management, collaboration & collaborative commerce, an overview of the Electronics industry, and the role of business strategy and value discipline thinking.

Chapter 1 – Introduction

This chapter functions as the introduction for the whole report. It gives an overview of the project's background, details the problem statement, the research approach and methodology, and the concrete deliverables.

1.1 – Problem Statement

Globalization, short product lifecycles, short time-to-market, more customer-specific products and decreasing prices are some of the issues the Electronics industry faces today [32], [77]. The last decades brought some major changes. Many companies in these supply chains have begun to concentrate on their core-competencies, typically no more than one or two processes, and therefore outsource much of their non-core processes [109]. Today's Electronics supply chains therefore are more complex, with many specialized players in the supply chain performing their own specific functions. For example, the largest part of manufacturing outsourcing is transferred, as a form of contract manufacturing, from the Original Equipment Manufacturers (OEMs) to the Electronics Manufacturing Service providers (EMS) [5], formerly called Contract Electronics Manufacturers (CEMs). See Figure 1.1 for a simplified overview of the structure of the Electronics supply chain, which shows the position of the EMS and OEM. The market for EMS companies is expected to show a large growth the coming years, due to the fact that the Electronics industry's size is still growing, and more importantly, that there will be an increase in outsourcing from OEM's to EMS's [5].

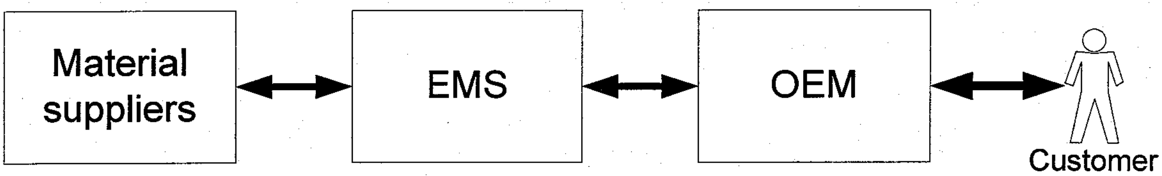


Figure 1.1 – Simplified industry structure, showing the position of the OEM and EMS

Due to all these changes, there is a growth in the number of inter-dependencies between the different players, the supply chain is becoming less linear than it was before and is evolving more and more into a network of interdependent companies, which is shown in a basic form in Figure 1.2 (source: [u29].

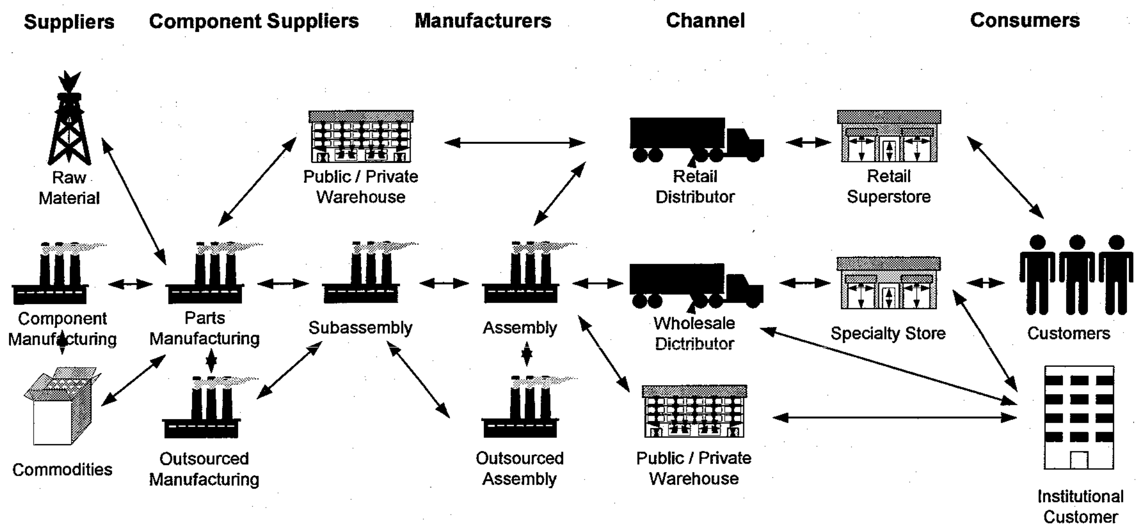


Figure 1.2 – The Electronics Supply Network

One of the largest risks of outsourcing is the natural gap that exists between two (or more) companies. Manufacturing outsourcing [3], for example, from OEM to EMS, faces the risks brought by the possibility of miscommunication and inefficiencies caused by the gap between those who design, market and sell the product, and those who manufacture it. Logical, since functions and tasks are no longer performed by a single enterprise, but are distributed and performed by different supply chain members.

To overcome this, to face the (end-) customers as one enterprise and also to improve speed, visibility and trust in the supply chain, the different companies in the supply chain need to synchronize their activities and processes, share information, and really start collaborating with one another. EMS companies, for example, can collaborate with their (most strategic) supply chain partners in the critical business processes, such as design, forecasting, sales, and customer support.

True understanding of the need for collaborative processes does not come without good understanding of company strategies. A company's strategy translates in its process focus; some processes become critical, others become less, or are even candidates for outsourcing. The same applies more applies more-or-less for supply chain wide strategies. In Electronics, chain dominance often lies with the OEM, which controls and directs the rest of its supply network.

Companies can choose from three different strategies, referred to as value disciplines [113]: customer intimacy, product leadership and operational excellence. By nature, an EMS company is intended to be operational excellent, and modern OEM's are either customer intimate or product leader. It may be very well possible that needs for collaboration, or at least the prioritization of these needs, depend upon the chosen value discipline and strategy.

Enterprise information systems are there to support the business processes of the company. Software solutions that target supply chain collaboration, therefore, are solutions to fulfill the different process needs in the industry. Before designing the proper solutions, first the important processes and current problems need to be explored.

Supply chain management (SCM) initiatives that target synchronization and optimization between network partners represent a large potential for the next decade. Although some serious supply chain management initiatives have been started, with sometimes very good results [88], its real potential still needs to be uncovered. Information technology, and therewith enterprise information systems, play an important role in SCM initiatives. Enterprise information systems drive the business, have the data to be shared with partners, and contain the basic processes for optimization and decision taking. Now it is time to move this beyond four-wall decision taking, and into the new era of network wide optimization and synchronization.

Enterprise software vendors and consulting firms are seeking – and currently struggle with – how to provide collaborative solutions for specific areas in the discrete-manufacturing area. Information system support for supply chain collaboration is the next step, and extends beyond the technology as is available today. The Electronics industry seems to be an industry that – as is the case for the Automotive industry – is ahead of other industries; from both an outsourcing, as from a technology application point-of-view. It already has a high rate of coordination and collaboration. Understanding the business in the Electronics industry can provide a key to success in other industries.

1.2 – Research project

1.2.1 – Problem definition

Knowing all this, this research project has been initiated with the following problem definition:

How should enterprise software vendors change their software products to help companies in the Electronics industry in confronting their collaborative challenges?

1.2.2 – Research questions

To provide a sufficient answer to the above mentioned problem statement, a research project has been initiated, with diverse purposes. The research questions for this project center around three central themes:

Firstly, it is important to widen the *knowledge and understanding of the Electronics industry*, and the *Supply Chain Management and collaborative commerce field*. Just as important is background information to start the analysis. Concrete questions around this theme are:

1. What are the key business issues companies in the Electronics industry face today?
2. What exactly are SCM, collaboration and c-commerce?
3. What are the differences between companies that have chosen a different competitive strategy?

Secondly, *knowledge of collaborative processes* is an essential element. How can companies collaborate, when are they likely to collaborate with business partners, and what are the choices companies make in their collaboration portfolio. Concrete research questions are:

4. Does a competitive strategy, directly translate in different collaboration needs?
5. Which elements influence collaborative processes?
6. Which collaborative processes are likely to emerge, and how do they look like?

Thirdly, it investigates the *essential elements in collaborative software environments*, focused on the Electronics industry. Background information and process knowledge is supplied, the next step is to map this with the practice of enterprise information systems, since these systems are there to support companies with their day-to-day processes. The more detailed research questions here are:

7. What software elements are essential in collaborative environments in the Electronics industry?
8. How does collaborative software map with available enterprise information systems?

9. What are the implications of supply chain collaboration for software and its architecture?
10. Which benefits can be provided with collaborative software?

1.2.3 – Report structure

This report is inline with the above-mentioned questions. Part I is the part that describes all *background* related issues, and it is mainly based upon literature study, domain expert- and field-input. Part II covers some of the important *collaborative processes*. It is not a complete and detailed overview of all processes that could be performed in a collaborative manner, but it combines all knowledge gained in Part I, and just focuses on the most interesting processes. The third part – Part III – describes *collaborative software*, covering both business requirements as software requirements. For this part, again, literature study was important, but most was based upon analysis of existing software solutions together with domain experts, and customers.

The report has two more parts. Part IV is an application of all theory, concepts and frameworks (process and software related) gained and developed in the earlier parts, in *the field of (collaborative) procurement*. A proof-of-concept, or practical application, in the procurement domain. By nature, procurement is already a process performed in collaboration with supply chain partners – which is also true for the sales function – since it communicates and exchanges information with partners outside the own enterprise. However, since for Electronics industry manufacturers, about 80% of the cost of goods sold comes from materials, it is a very interesting domain to widen the knowledge and to apply modern insights.

The last part of the report (Part V) is used for evaluation of the research questions and discussion. The thoughts discussed can function as a good starting point for further research and development.

1.3 – Research approach

In this research project a mixed approach is used, which is partly empirical, partly case based and partly modeling based. Literature study, and input from domain experts and companies from within the Electronics industry function as the basis for all findings, and the foundation for analysis, and the development of the framework and concepts in the later parts of the report. All information is captured through reading, conversations with experts within Baan and Deloitte&Touche, contact with Industry analysts (such as the Aberdeen Group and AMR Research) and meetings with Electronics industry companies (with Neways [u23], Omron [u25], Flextronics [u15] and Elcoteq [u12]). This research approach has been chosen since it is the fastest way to capture much information. Other methods, such as survey based, or modeling based do consume more time and generally do start with some hypotheses or frameworks, which were not available here, to validate and build upon.

1.4 – The deliverables

Originally this research project started with three concrete deliverables. The first one was a *usable concept* to map and translate the industry needs and strategies into collaborative processes. This concept (or framework) should serve as a foundation for the collection of software requirements. The second objective was an *overview of important elements* for collaborative software.

The third objective was to initiate some *prototyping or pilot-design work/development* upon the ideas and concepts as collected and delivered by the first two objectives. However, due to a combination of factors, this turned out to be hard to realize, and therefore it was decided to detail *an extended business case* in the procurement domain, and to show the application of the theory as collected and developed in the rest of the project.

These deliverables help companies in the Electronics industry, enterprise software vendors, and consultancy firms to figure out how to grow their collaboration strategy, based upon the as-is state of today, and the collaborative tools available now and in the nearby future. Furthermore, it provides the academic community with a better insight in the way these kind of companies function in their supply chains, and thus a better starting point for further research.

Chapter 2 – SCM and Collaboration

Currently, *Supply Chain Management* (SCM) as well as *collaboration* are buzzwords; and therefore there exists some confusion, mainly centered around the terminology. Here, an overview of different definitions is provided, and a SCM model is introduced, which will function as the basis for much of the further research. Special attention is paid towards the issues of trust, information technology and supply chain costs. Furthermore some attention goes to different ways to collaborate, and the concept of outsourcing.

2.1 – The need for cooperation or collaboration

Today, due to increased product-customization on one hand, and technological innovation on the other, the need grows for co-operation, or collaboration, between specialized organizations [69]. Not being able to co-operate with other specialists decreases the attractiveness of the specialist's product or service.

One of the main incentives for collaboration could be limiting risk in a dynamic environment, as has led to collaboration for many years in industries such as oil exploration. Therefore inter-organizational collaboration should be seen as part of the organization's strategy, not as a choice to be made at an operational level [69]. Strategic analysis and decision making is needed to figure out which processes to integrate between partners.

2.2 – Background & definitions

Despite the popularity of the term Supply Chain Management (SCM), both in academia and industry, considerable confusion as to its meanings remains. Some define SCM in operational terms involving the flow of materials and products, some see it as a management philosophy, and some view it in terms of a management process. This paper uses the following definition of SCM:

> *"Supply Chain Management is defined as the systematic, strategic coordination of the traditional business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole." [84]*

SCM in the market for enterprise software means something different than in academia. In the enterprise software market, vendors have positioned their Advanced Planning & Scheduling systems (APS) as SCM tools. In practice, however, these tools do only optimize and coordinate within the organization, and not across different companies in the supply chain. Enterprise software vendors (such as Baan, SAP, i2 Technologies, etc.), consultants, and the industry analysts (such as Gartner, AMR Research, Forrester, etc.), speak about collaboration in regards to software solutions for managing processes across companies in the supply chain. Throughout this paper the following definition of collaboration will be used:

> *"Collaboration is the process of working together toward a common purpose or goal in which the participants are committed and interdependent, with individual and collective accountability for the results of the collaboration, and each of the participants shares a common benefit." [75]*

It is clear that these two definitions of collaboration and supply chain management have much in common. Both definitions include business partners working together, to derive benefits from this and to improve supply chain efficiencies.

2.3 – Supply Chain Model

2.3.1 – An Academic Model

As there are many definitions for supply chain management and collaboration, there are also many different supply chain models. Figure 2.1 shows the one used in this report. It is based upon [84], but has some slight adjustments. A large difference with traditional supply chain models – which look at each of the various companies – is that this model takes the supply chain, with different partners, as the basis.

In the center of the model, *nine functions* are placed which need to be fulfilled by the supply chain as a whole, such as Research and Development (R&D), forecasting and sales. Please note, that design is part of the research & development function in this model, and that the term logistics includes both distribution and inventory management.

Part of this supply chain model is an overview of the *enablers for inter-functional coordination*, such as trust, commitment and behaviors. The *supply chain flows* (such as products, services, financial resources, and information) are there, as are the *benefits* the supply chain brings. In the end it is all about customer satisfaction, value creation, profitability and competitive advantage over other supply chains; elements shown in the point of the arrow.

Information systems, *human resources* and *plants, equipment & facilities* are positioned in a separate part of the model. These aspects support the operation of the different functions, by the individual companies and by the supply chain as a whole.

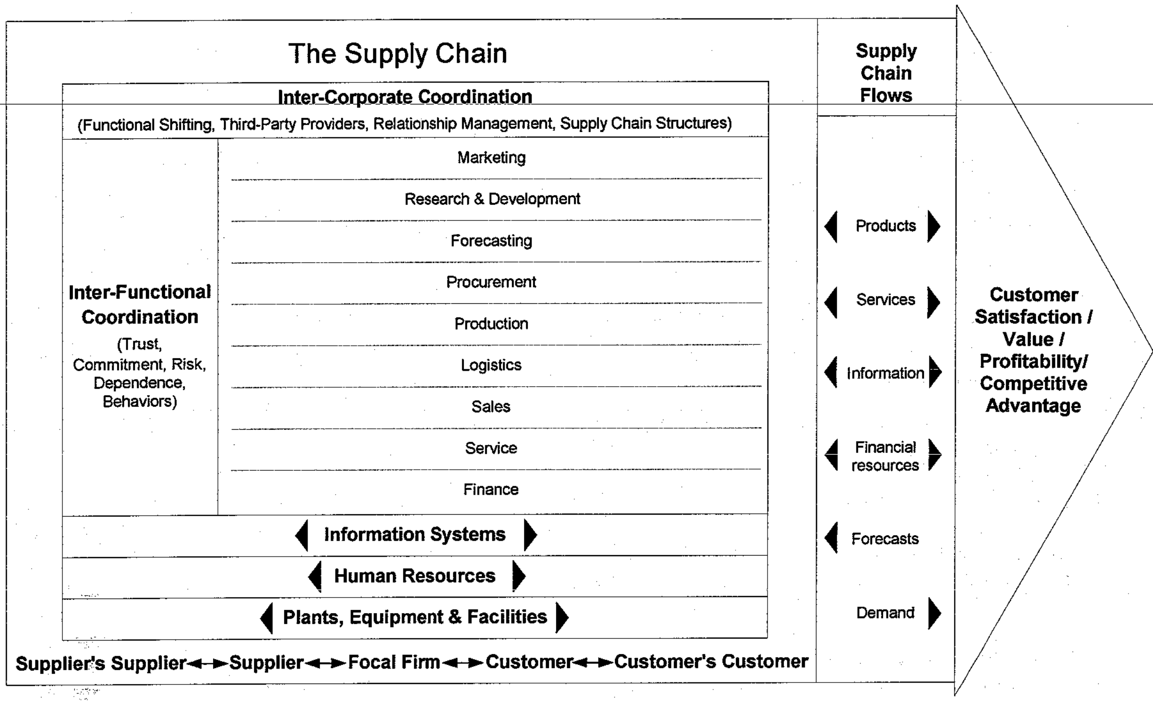


Figure 2.1 – Model of supply chain management

2.3.2 – Inter-Functional Coordination

Trust, one of the main aspects of *Inter-Functional Coordination*, is an essential element in collaborative relationships between supply chain partners, since it encourages the partners to share information and cooperate [7]. One of the root causes for a lack of trust is a lack of understanding of each other's planning processes and, even more, each other's businesses [10]. Strategic relationships are the logical place to start collaborative initiatives, since the required trust and structures do already exist [70], [126].

It is shown that high levels of trust can be achieved, when supply chain partners put hard work in building a collaborative relationship. Once this is accomplished, the partners will find themselves in a vicious cycle of steadily improving supply chain performance, leading to even higher levels of trust and transparency, which in turn will improve performance even further. See [10] for an illustration. Sharing the benefits of cost savings that are realized with the supply chain partners could be beneficial as some of today's best examples do show (i.e. Cisco and its partners) [88].

2.3.3 – Information Systems

Information technology and its application in the area of inter-organizational collaboration is a very important aspect of this report. The later parts of the report (i.e. Part III) are largely devoted to it. Nevertheless it is useful to mention and review its basic role here already.

It is good to note that the role of information technology is not only communication and data distribution, but it includes also the less obvious tasks such as sharing performance information and exception handling and resolution. Collaboration implies the integration of business processes and relationships, and information technology is an important enabler herein [88], [91], however other aspects (as mentioned earlier) are important as well. In many supply chains, the only information that is currently exchanged concerns orders [123], exchanging other information types could be beneficial. That makes it an important subject for further research. Example 2.1 shows some concrete examples of how Information and Communication Technology (ICT) can boost supply chain performance.

Example 2.1 – How ICT could improve supply chain performance

Table 2.1 shows some examples on how ICT could improve business. Some more examples can be found in [81].

Table 2.1 – ICT issues and corresponding Business issues

ICT issue	*Business issue*
Minimization of time lags between entities	Decreased financial payment cycle times
Real-time communications across multiple levels of partners	Increased speed of response to demand signals
More efficiently designed visibility processes among entities	Clearer understanding of causes, effects, and alternatives to events
More intelligent monitoring of operational KPIs (Key Performance Indicators)	Faster exception response and execution flexibility
Faster order management, fulfillment and delivery processes	Increased share of customer wallet and customer satisfaction
Real-time execution management and control	Increased creativity and effectiveness of problem solving
Synchronization of disparate information sources	Higher increases in employee productivity

Putting it simple, collaboration between business partners has its value there where production decisions need to be taken and where exceptions and problems need to be resolved. Information plays a vital role here, both within the organization, as with (external) supply network partners. Collaborative commerce therefore is not only limited to the exchange of information with partners, a solid integrated information environment in the own enterprise is an essential element to success as well [88], see also the next section. ICT is there to support the business, and so it helps to minimize costs and optimal decision taking, by *information-sharing*, *decision-sharing*, *process-sharing* and *resource-sharing* [120].

Business cannot proceed without good information and communication technology anymore, it is very important. Some experts even state that the major changes in information and communications technology can be considered as the second economic revolution [43].

2.4 – Collaboration

Collaboration can be performed in different ways. Figure 2.2 gives an overview of areas that could be interesting to deploy collaborative initiatives. Area *one* is about internal collaboration, within the same enterprise and same plant. Perhaps obvious, but it turns out that even here much could be improved. The *second* area also includes collaboration within the same enterprise, but over and between different plants and locations – often referred to as multi-site. The *third* area is about collaboration with external partners, in this case a partner at the supply side. Number *four* shows collaboration with a customer. Number *five* is slightly different, since it does not contact the own company, or a partner, but the final customer of the supply chain. This kind of collaboration can improve the (customer-) service orientation of the supply chain. Number *six* shows collaboration over the supply chain with all pre-defined relationships. The *seventh* form even extends on this, and makes it more dynamic and could include all possible partners, so not only the current partners, in the collaborative initiative. It actively searches and monitors for new relationships, and enables them, where option six is more pre-defined. That is, theoretical, the ultimate mode.

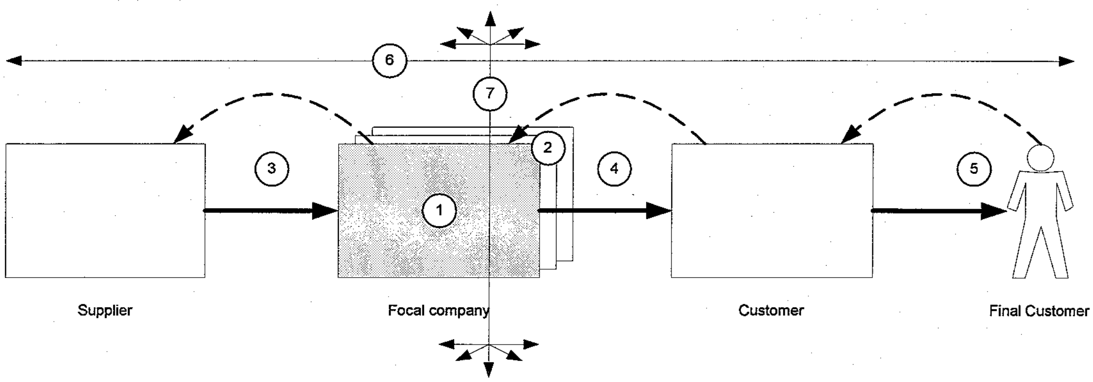


Figure 2.2 – Interesting areas for supply chain collaboration

2.5 – Outsourcing

Outsourcing is the concept, in which tasks, that used to be performed by the company itself, are now performed by partners, who offer their skills to the company. Although outsourcing as such is not included in the here presented SCM model, it has all to do with it. Almost all large companies do actually outsource processes; and therefore have a need for some coordination and collaboration between the (outsourced) business functions, and partners.

The two main reasons [74] to outsource a business process are: (1) An organization cannot perform the process at an adequate level to compete. (2) The process does not contribute to an organization's competitive differentiation and should either be outsourced, or eliminated to free up resources.

2.6 – Supply chain costs

Cost is a very essential element in both ICT and supply chain management improvement projects, and an implicit and explicit part of the SCM model. It is useful to have insight in the different costs that do relate to different supply chain management issues, to get a feeling for improvement issues.

Supply chain costs generally range from 10 to 25 percent of the total costs of an enterprise [103]. These costs do consist out of three different parts: core costs, noncoordination costs, and transaction overhead costs. *Core costs* are half of the supply chain costs, a third are *noncoordination costs*, due to the poor coordination between supply chain partners, and the remaining sixth are *transaction overhead costs.*

Early Internet based commerce was primarily focused on automating transactional procedures. Although this brought cost savings, it did not materialize all possible cost savings, since it only tackled the *transaction overhead costs*, a relative small part of the possible cost savings in the supply chain area. Elimination of these supply chain costs shall bring more value, especially in the long-term, than relentless pricing pressures will do [81]. Full impact of (Internet) technology and its capabilities will come when companies look beyond those transaction overhead-minimizing initiatives. By using this technology to optimize coordination and collaboration between supply chain partners, and from improving the structure of the supply chain itself.

The *noncoordination costs* are the result of sub-optimization of the linkages between supply chain partners, due to four-wall thinking. Supply chain wide optimization and balancing are ways to improve here. The *core costs* can only be tackled via supply chain restructuring or innovation initiatives and are harder to achieve.

2.7 – Summary

In this chapter the terms supply chain management (SCM) and collaboration are explained in more detail. There is a serious difference between SCM as explained by academia and the same term when used by enterprise software vendors, consultants or analysts.

A fresh supply chain management model is introduced, and explained and described in detail. The model is based upon recent literature, and shows the whole supply chain in one model, a single unity that has to fulfill different functions together. Although it is a theoretical model, it is a useful instrument, which provides an overview of all essential elements in the supply chain management field.

Special attention is paid for trust and ICT issues. Both turn out to be essential elements in successful collaborative relationships. Such relationships center around information-sharing, decision-sharing, process-sharing and resource-sharing. However, the model shows that for real collaboration, more is needed than only ICT.

Collaboration is not just about sharing some information with a partner. Instead, collaboration can be performed in many different modes. From very internal focused (e.g. function within the enterprise) to network wide initiatives.

The last part of the chapter looks at supply chain costs. Although automation of transactional procedures can result in cost savings, it is just a beginning. SCM, collaboration, and the application of enterprise software can result in much larger savings, when applied the right way.

Chapter 3 – The Electronics Industry

Focal point of this chapter is the Electronics industry. First the focus is on the changes that have occurred in this industry over the last decades. Manufacturing, for example, is no longer performed by Original Equipment Manufacturers (OEMs), despite their name. It is largely done by Electronics Manufacturing Services providers (EMS), which have taken over an important part of that job. This outsourcing trend, combined with some other key business issues (listed in this chapter), explains the need for collaboration in this industry.

Academic theory helps to get a feeling for the key issues in such supply chains. It is compelling to see how much the Electronics industry has in common with parts of the Fashion industry supply chains. The need for agility, a focus on low costs, and the management of a highly variable market turn out to be the main themes to control.

3.1 – Definition

The Electronics industry is the business of creating, designing, producing, and selling electronics equipment. Varying from devices such as mobile phones, computers, routers, telephone exchanges, and semiconductors [u13]. Furthermore this industry produces many specialized parts that will be used within other industries like for example the aerospace and defense, the automotive, and the medical industry. The total market size, for the Electronics industry, was around $700 billion US, in the year 2001 [5].

3.2 – Supply chain evolution

3.2.1 – Yesterday

Before the 1980s, the supply chain in the Electronics industry could be characterized – in general – as shown in the upper part of Figure 3.1. This figure is based upon the simplified figure as shown in Figure 1.2, and not on the more complex Figure 1.1. Original Equipment Manufacturers (OEMs) got their material from material suppliers and manufactured that into products they delivered to their customers. Sometimes they outsourced part of the production to companies referred to as Contract Electronics Manufacturers (CEMs). OEMs turned to outsourcing mainly to provide supplemental manufacturing capacity during periods of high demand [34], [108]. The relationship between OEMs and their CEMs was thin. The work was contracted on a consignment basis, and it was easy for OEMs to move work from one CEM to another. This situation is graphically shown in the second part of the same figure.

Changing production technology in the 1980s and early 1990s was the major deciding factor that resulted in a shift in the supply chain operations structure. OEMs started to use CEMs more and more as their primarily production facilities. It did not make sense for OEMs to invest in all the expensive equipment themselves, CEMs could achieve better equipment utilization, because they could combine work from multiple OEMs – the manufacturing processes itself are easily standardized, but companies and supply chains are searching for best business practices [30], [61], [77]. Therefore the role of CEMs was changing from *additional capacity* for the OEMs, to providing (cheap) technical *manufacturing expertise* that OEMs did not have.

3.2.2 – Today

In the 1990s large contract manufacturers began to differentiate themselves as Electronics Manufacturing Service providers (EMS). They started to function more as the operating departments of OEMs, offering superior Total Cost of Ownership. OEM companies in the Electronics industry have been shrinking non-core competencies and focusing intensely on their core competencies [3], which may or may not include actually building products. EMS companies [31] offer engineering, design, procurement, testing, assembly, order-processing, distribution, and after market support (such as repair services). See third part of Figure 3.1; the dashed lines indicate optional relationships.

Note, that the real network is far more complex than the simplified drawing in this figure. The network never consists out of only one-to-one relationships. An OEM works with more EMS companies, and an EMS has several suppliers. Furthermore, the network is not as linear as shown in this figure. It happens that the OEM orders the materials for the EMS, just like EMS companies buy directly material from raw material suppliers. Another aspect not included is the role and position of distributors and transportation or third party logistics (3PL) providers. Altogether, the figure provides a very simplified view on this industry. It is only describing the position of the basic players in the supply chain.

The role and function of the different companies in the Electronics supply chain has changed. Most functions are performed more diverse today [3]. The OEMs retain control of engineering and design, but they have shifted some other activities to other places in the supply chain. Now, OEMs take orders directly from the customer, contract manufacturers fulfill directly to the customer, and third-party logistics firms handle consolidated shipments [3]. However, the supply chain tries to operate as if it were one company.

3.2.3 – Tomorrow

An expanded role for the EMS, in comparison with its current role and OEMs role as of today, is likely to originate. Tomorrow's OEM will only concentrate on the contact points with the end customers, and outsource all other activities to other companies in the supply chain. In practice this means that an OEM is likely to concentrate on sales, marketing and high-level design.

The role of EMS companies in the Electronics supply chains is expected to grow in importance, as is illustrated in the bottom part of Figure 3.1. The EMS, coming from a role of a simple manufacturing partner, makes a strong move into the procurement/sourcing and design area. The sourcing processes will be organized primarily through the EMS, and no longer be strongly controlled by the OEM. A logical change, since the EMS's can use their buying power (economies of scale), and knowledge of the manufacturing and logistical processes, to achieve best-in-class procurement.

For the design processes, it is slightly different. The OEM's power lies in its contact with the (end)-market, and the EMS has the best knowledge of the manufacturing processes. Therefore it is likely that the design stage will become a series of collaborative processes, where all supply chain partners (i.e. EMS and OEM) bring in their best knowledge on product design and combine their efforts in good designs.

Large EMS companies could grow in to a role of network orchestration [23], [76], although generally the power in the supply chain is likely to remain with the large OEM'S (such as Dell, Cisco and Sony) or part-suppliers (such as Intel). The EMS is there to support the needs of these dominant players. Note that a highly simplified overview of Cisco's supply network (with itsmain EMS companies; and their suppliers) can be found in [59] and [88]. It is shown that Cisco has strategic relationships with (at least) three EMS providers, and four important material suppliers.

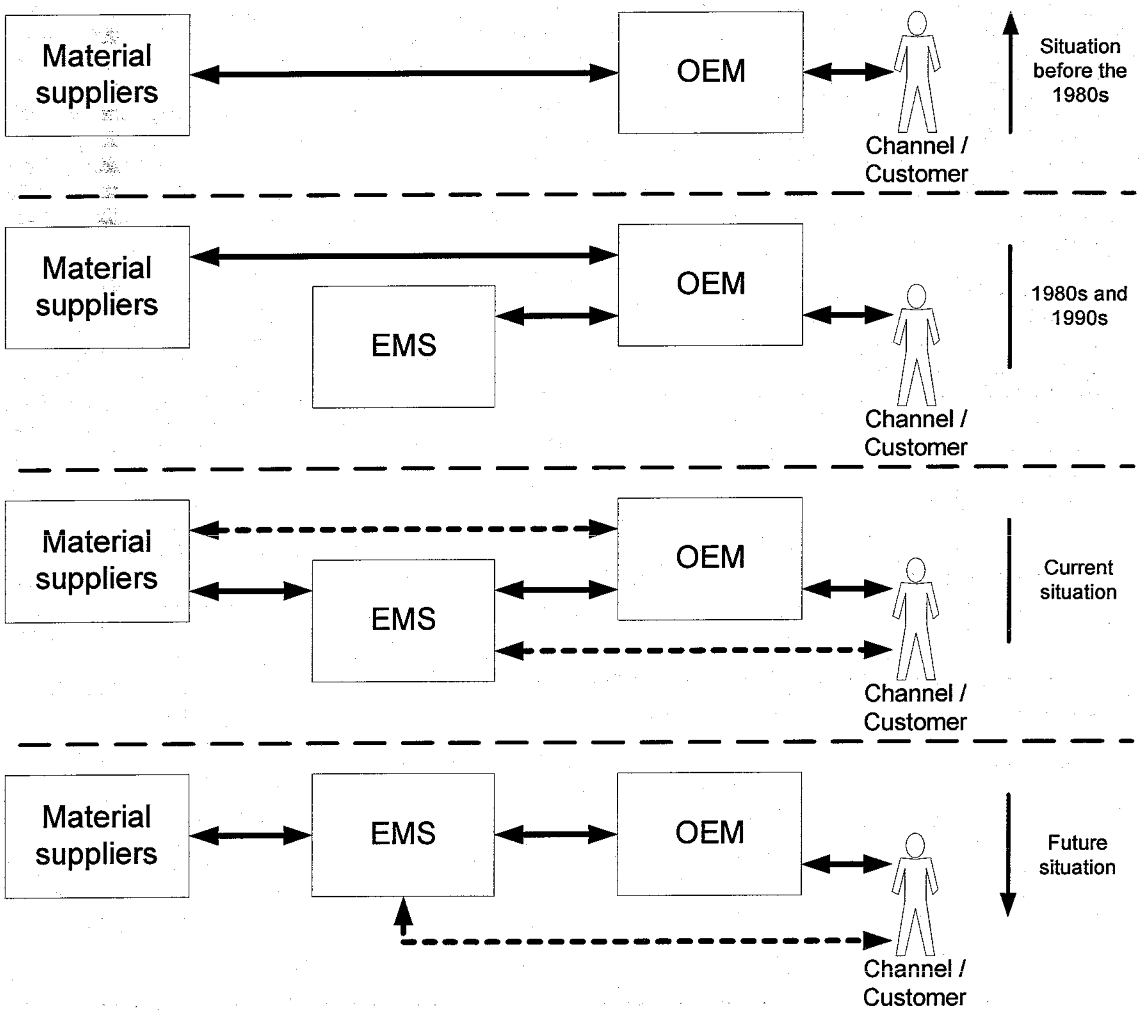


Figure 3.1 – Industry diagram illustrating the changes in the Electronics industry

3.3 – Outsourcing and the EMS

In 2000, approximately 25 percent of all Electronics production was outsourced. EMS providers do not capture all the outsourcing. Some outsourcing goes to less-known entities referred to as original design manufacturers (ODM) [109]. In addition, there is OEM-to-OEM outsourcing, especially large in the market of computer OEMs [5]. This focus in this research was solely on outsourcing to EMS companies, and not on these other modes of outsourcing. From a supply chain perspective outsourcing to an EMS is most interesting, since they really operate as a company central in the network, for which collaboration and cooperation with its network partners (suppliers, customers and competitors) is essential. The other outsourcing modes, and their collaborative challenges are interesting as well, but no focal point in this report, to keep it simple.

In Appendix 1 a detailed overview of the world of the EMS's can be found. Important conclusions are that the main reasons to outsource production from OEMs to EMS providers are cost savings and lacking (currently, or foreseen) expertise from both a technical as a quality perspective. For EMS companies, most business comes from the product categories computer/office and communications – with products such as personal computers, PDA's and mobile phones.

Especially the companies in the top rankings of the EMS market (such as Solectron and Flextronics) have grown enormously over the last years. By expansion, but most of all by acquisitions of other EMS companies or OEM's facilities. The total EMS market is expected to grow at about 20% each year during the coming four years, for different reasons.

3.4 – Key business issues

Many sources do describe the key business issues the Electronics industry is facing. Combining some of these sources [10], [27], [30], [32], [77], [98] provided the following list of issues:

- Speed of innovation, first–to-market, time-to-market, and time-to-volume are critical
- Reduced (and short) product lifecycles (between 0.5 and 1 year)
- High dependency on just a few key items
- Decreasing prices
- High Research and Development (R&D) and marketing costs
- Customer centricity
- Globalization
- Industry growth rates are beginning to slow

Although this is a recent list of issues, it is no completely new list. However, due to growing competition profit margins have decreased over the last years. Outsourcing becomes a more logical instrument, due to the focus on the core competencies of the different players in the Electronics industry. Chapter 4 will make this more clear.

Two aspect needs to be mentioned separately: First, the problems around multiple children Bill-of-Material's (BOMs). Much products can be built via different alternative BOMs – and behave as the same end product. This is both a thread as it is an opportunity; although it makes the management of the parts more complicated, it opens up the possibility for smart optimization. More info can be found in Appendix 5.

A second problem – that partly relates to the issue above (also described in Appendix 5) – are article numbers. Parts from other suppliers – which have the same function and characteristics – do have different part numbers. Therefore it is very complicated to use parts from others than the preferred supplier, from whom the article numbers are known. Optimization of alternatives is therefore quite complicated. In the past these problems have turned out to be a major obstacle in many supply chain improvement, integration or collaboration initiatives.

3.5 – Collaboration in the Electronics industry

As the previous section showed, most of the issues listed are cost or time related. Collaboration between supply network partners therefore is a very logical step, since working together in the different processes can reduce costs and save time.

A large risk the new structure of the Electronics industry – as shown earlier in this chapter – brings, is the possibility of miscommunication and inefficiencies caused by the gap between those who design, market and sell the product (e.g. the OEM), and those who manufacture it (e.g. the EMS). To overcome this, to face the (end-)customers as one enterprise, and also to improve speed, visibility and trust in the supply chain, the different companies in the supply chain need to synchronize their activities and processes, and really start collaborating with each other.

The changes in the structure of the Electronics industry require a closer collaboration between business partners in a supply chain. Instead of an OEM taking optimization decisions within its own corporate boundaries, a company is now part of a larger supply network. Optimization decisions now have their impact on network partners as well, and simple local optimization is not enough anymore, since local decisions can affect (both in a positive and negative way) the overall performance of the supply chain. Positive herein is that many relationships in the Electronics supply network nowadays are of the strategic type [70], and as chapter 2 showed, this is an enabler for collaboration.

So far unmentioned is the fact that the final products from this industry are often a system or tailored solution, which involves some combination of infrastructure, hardware, operating and applications software, and implementation and hosting services. More than normal products, these products are not designed, built, and delivered by one single company, and therefore it creates a natural need for collaboration in the supply chain.

3.6 – Supply chain typology

3.6.1 – Different categories

The products delivered by the Electronics industry can be divided into two main categories:

1. High-volume / low-complexity. Products produced under a make-to-stock (MTS) or assemble-to-order (ATO) policy, like for example mobile phones, computers and routers. These products are produced in large series (high volume) and the related complexity is relatively low. The margins are relatively low, and the market is cyclical. OEM's such as Nokia, Microsoft, and Sony are active in this market.
2. Low-volume / high-complexity. Products produced under an engineer-to-order (ETO) policy, such as for example large PBX's, specialized electronic parts for military equipment, etc. These products are relatively complex to produce and the volume is low. Each series is more-or-less a project on its own, and the market is less cyclical than it is for the other category. Some examples of this category include Barco, and Nortel.

The supply chain characteristics of the two groups do differ. The focus in this report will only be on the first group of products (high-volume / low-complexity), especially while this group represents the largest part of this industry (approximately about 85%) [5]. Further research is needed for the other category.

Many experts foresee a general cross-industry move from make-to-stock (MTS) towards make-to-order (MTO) environments. Although this might be partly true, many products in the high-volume / low-complexity segment will remain to be built against forecasts, while sales keeps on going from stock. Perfect examples are mobile phones and almost all the products in the consumer electronics segment. The simple explanation is that there is a huge disparity between the response time customers want, and the cycle times of the component suppliers, especially the semiconductor manufacturers. Even in direct sales models – such as Dell has – component manufacturers must forecast, make-to-stock and hold inventory close to the assembly sites.

More information about the difference between the different production typologies (MTS, ATO, MTO, ETO) can be found in Appendix 2. This appendix does also give an overview of some of the disadvantages of i.e. the MTS production typology.

3.6.2 – Fashion typology

The supply chain typology of this category of products (high volume / low complexity) from the Electronics industry shows a large similarity with the *fashion segment* of the apparel industry [47], [102]. Typical aspects are its high value density, short life cycles, innovative products, unpredictable demands, obsolescence rates, etc. A responsive supply chain is needed and so control and optimization center around four themes: transition management, forecasting, inventory management, and lead-time reduction. All to reduce and avoid uncertainty.

The *transition management* theme is important, as it is demonstrated by the fact that the contribution margin is high at new product launch. It is better to ensure supply in such cases, for example by a 'surplus' in capacity. Furthermore product manufacturability is important, since it can be influenced in the design phase. Reducing the design lead-time can be beneficial as well.

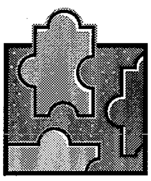
Long supplier lead-times and a limited flexibility underline the importance of *forecasting*. The range of end products is large, resulting in unreliable forecasting, but there is high component modularity. This results in forecasts at product family level, for products and components. Sharing information along the chain is seen as critical, in especially good feedback of point-of-sale data.

The high value density of the products is not the only aspect that asks for *inventory management*. The difficulty to forecast at item and outlet level, for the end products, also demands for inventory management and rapid replenishment. The high cost of key components and materials require maximized component commonality, and well managed component inventory levels.

High obsolescence rates, a short time of sale-ability, and a short model half life time request not only optimal product transitions but also *lead time reductions*, or a reduced time-to-market. Furthermore customers become more demanding every day and require shorter lead times. This relates to faster product development processes (e.g. from idea to product), and shorter fulfillment times (e.g. from order to use). Combined with the large range of end products, manufacturing postponement does seem to be a solution, which pleads for a move of the customer-order-decoupling-point (CODP) from a make-to-stock (MTS) environment more towards a make-to-order (MTO) environment.

3.6.3 – Trade-off lost sales and obsolescence

Part of transition management are *lost sales* and *obsolescence* [29], [49], [71], which are interdependent. It would be easy to achieve zero lost sales, for example, by over-stocking everything up to the hilt, but the obsolescence cost of this approach would be formidable. In the early part of the product life cycle on hand inventory is critical to achieve zero lost sales. However, at the end of a product lifecycle (or season) a surplus of obsolete items can become very costly. The challenge is to find the optimal trade-off between the two factors, which will vary from situation to situation. Measuring the 'immeasurable' – namely obsolescence costs and lost margins on missed sales – is an important instrument in managing this trade-off process, since it provides the company with valuable insight in the market situation. Collaboration between the channel partners is very important, since manufacturers overlook the problems from another perspective than retailers do.



3.7 – Summary

The supply chains in the Electronics industry have changed over the last decades. OEMs do not design, manufacture, distribute, market and sell all their products on their own anymore; tasks have been distributed over specialized players in the supply network (e.g. EMS companies, and 3PLs). Each company in the network focuses on its own core competences, and for an OEM this is no longer manufacturing. EMS companies have their background in additional manufacturing capacity for the OEMs, but have been moved in a position where they are the primary manufacturing partners for the OEMs. In the nearby future they will largely take over the *procurement/sourcing* functions of the OEM, as well as they shall become an important partner for the OEM in its *design* processes. Simply, since the EMS has the knowledge of the manufacturing processes, which is an essential element for good designs.

The category of *high-volume / low-complexity* products has much in common with the Fashion industry. The common key business issues are: A high value density, a short product life cycle, a need-for-speed, and high obsolescence rates. To control supply chains like this four themes need to be managed: transition management, forecasting, inventory management and lead-time reduction. The *trade-off between lost sales and obsolescence* is an important part of the transition management theme.

Supply network-wide optimization and *collaboration* with supply chain partners is key for competitiveness in the following years for all companies in the Electronics industry.

Chapter 4 – Value Disciplines

There are three different disciplines wherein companies can differentiate themselves from their competitors: customer intimacy, product leadership, and operational excellence. This so-called value discipline thinking is the basis of this chapter.

The first part of this chapter shortly describes the three value disciplines and the importance of focusing on one of them. In the second part, the value discipline thinking is applied to the Electronics industry and the role and function of the Original Equipment Manufacturer (OEM) and Electronics Manufacturing Services provider (EMS) in especially.

4.1 – Three value disciplines

Today's companies can excel and gain competitive differentiation through three different value disciplines [48], [50], [72], [95], [112], [113]: customer intimacy, product leadership and operational excellence. A value discipline is a company's ability to allow operations, structure, systems and culture to contribute to a set of clearly related business objectives. Objectives are either customer related, product related or process related. Bundling all three value disciplines into a single company inevitably forces management to compromise the performance of each process in ways that no amount of reengineering can overcome, simply while the economics of the disciplines conflict. Therefore, combining all areas in one single company seems to be really difficult.

- **Customer intimacy**: A company that focuses on *customer intimacy* offers its customers tailored products and services, which requires an intensely service-oriented culture. It stands for segmenting and targeting markets precisely and then tailoring offerings to match exactly the demand of those niches.
- **Product leadership**: For a company where *product leadership* is the key competitive differentiator, speed, not scope, drives the economics. Innovation is rewarded and administration is minimized. The company offers its customers leading-edge products or services, that consistently enhance the customer's use or application of the product or service, thereby making rival's goods obsolete. It is constantly pushing the boundaries of product performance.
- **Operational excellence**: If a company wants to excel in *operational excellence* it tries to use its operational facilities as optimal as possible, based on the high-fixed costs it faces, and on its capital-intensive facilities. The focus is on delivering its customers reliable products or services with minimal difficulty or inconvenience. These companies do the same as their competitors, but to lower costs.

4.2 – Focus is the key

Focus on one of the three value disciplines is the basis for competitive advantage. This can be explained twofold, by both the concept called *the zone of indifference* as well as with the growing influence of *modern information technology* in current industries.

The zone of indifference theory explains that the customer only recognizes company improvements if these improvements break through a certain border. If they do not pass this border, it may be better to do not invest in improvements at all. Concentrating on one single value discipline might be the best option, since it moves a company outside the zone of indifference, and thus provides more – and recognizable – value to the customers. More information regarding the zone of indifference can be found in Appendix 3.

The introduction and implementation of new information technologies brings many improvements and advantages (like lowering the interaction costs), but on the other hand it makes it more difficult for companies to capture the benefits it creates, since best practices become easier to copy [95]. Having a middle of the road strategy, where a company tries to become a champion in two or even three value disciplines, results in easy to copy best practices. A company that focuses on only one value discipline might have the chance to build true value in its information systems, which may not be that easy to copy. Once again, focus is the key word.

Although focus on one value discipline is the key to success, this does not mean that the other disciplines can be simply ignored. A market leader, with a strong focus on one value discipline, needs to meet at least the industry standards in the other disciplines. The zone of indifference theory shows that the industry standard can be easily met, since it is located on a fairly broad indifferent zone, and that it is much harder to move beyond the industry standard.

4.3 – Application of value discipline thinking

4.3.1 – Natural role

Over the last two decades OEMs started to shift their focus more and more towards customer intimacy and/or product leadership, and started looking for opportunities to outsource their no-longer-core processes, such as production and logistics; see the upper part of Figure 4.1 – the light-gray parts show the functions that are outsourced from the OEM to the EMS, or performed in a collaborative manner. EMS providers were (and are) the logical choice for outsourcing the no-longer-core manufacturing processes (see also Section 2.5), with their strong value discipline focus on operational excellence in production and logistics; which can be seen in the same Figure as well [48].

The basic role of an EMS is legitimized by its structurally lower manufacturing costs than its OEM customers have. Reliability and expertise are other reasons for outsourcing from OEMs to EMSs (see Appendix 1 for more details). Therefore, the role of an EMS – in the Electronics supply chain – is that of the specialist in operational excellence.

4.3.2 – Excel in one discipline

To differentiate itself from other EMS companies, and to enforce its competitive position, an EMS company can choose to excel in one of the three value disciplines, thereby meeting the high standard for operational excellence directed by the industry structure. By choosing a different strategy than competitors do, an EMS can become more appealing to its OEM customers, and establish a defensible position against other EMS's. In that case, however, the EMS needs to realize that it needs to offer those functions are features that allow the customer to justify paying more than the low cost (pure operational excellent) alternative. Hereby an EMS can go two routes – just as any other services company: it can take over the complete business function (i.e. manufacturing related) from the firm it works for (e.g. the OEM), and/or it can collaborate on those functions that are core to that firm. The latter strengthens the position of an EMS, since it gets important to the principal. The value discipline that is chosen has its impact on the importance of the different functions [48].

4.3.3 – Superb operational excellence

An EMS company that chooses to differentiate itself from other EMS's by an even stronger focus on operational excellence than competition tries to offer lowest total cost through a combination of price, reliability and service. Operational excellent strategies just concentrate on the best possible coordination or rationalization of the core manufacturing processes like procurement, production and the logistics. Therefore these are the typical functions it excels in (see Situation A in Figure 4.1).

4.3.4 – Specialization in customer intimacy

A focus on customer intimacy for an EMS means that it creates a relationship with the (end) customer, or works collaboratively with the OEM, perhaps even at the customer facing side. Everything is focused on delivering tailored products and services that satisfy unique customer needs. Sales, service, and probably also fulfillment, are handled (or coordinated) through the EMS, and some products do not touch the OEM anymore. Therefore the EMS needs to extend its functions beyond the more traditional procurement, production and logistics domains, and take up the sales and services role as well. Situation B in the lower part of Figure 4.1 shows this.

4.3.5 – Specialization in product leadership

EMS companies that try to excel in product leadership are constantly pushing the boundaries of product performance. The setup of so-called 'new product introduction centers' and (joint) R&D programs (together with both suppliers, as customers) are good examples of such EMS companies.

Not surprisingly, a product leadership strategy results in a focus on (collaborative) design, or in other terms R&D and marketing. In Figure 4.1, this situation is shown in situation C.

4.4 – No easy choice

Cost advantages are less perishable than customer binding or a product market leadership [95]. Therefore, an EMS company can be attracted to shift its focus more towards customer intimacy or product leadership, while remaining operational excellent at industry-standard level. So, it does not only strengthen its competitive position, but it also has a way to achieve higher profit margins. Take a look at Appendix 4 to get a feeling for the profit margins for different (types of) companies in the Electronics industry.

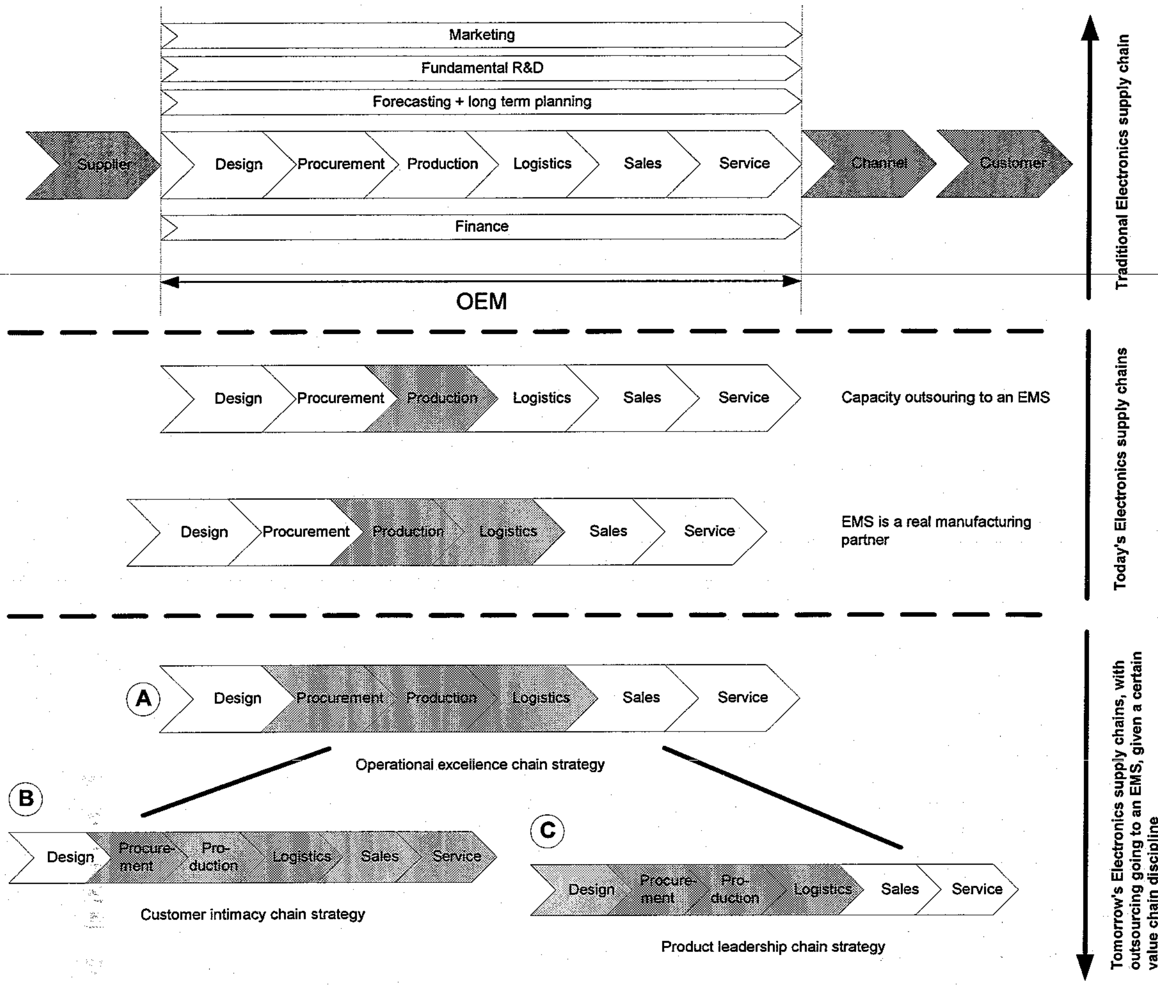


Figure 4.1 - Outsourcing from OEM to EMS

Note that although large EMS providers have become more powerful over the years, the chain dominance is still mostly concentrated with the large OEMs (such as Dell, Cisco, and Sony) or part-suppliers (Intel). The EMS is there to support the dominant player(s) in its supply chains. Example 4.1 gives a good reflection of the different relationships between EMS and OEM, where the OEM value discipline is leading.

Example 4.1 – OEM-EMS relationships and Value Disciplines

Sony and Apple are perfect examples or product leaders in the Electronics industry [48]. IBM is the perfect example of a company with a customer intimacy focus. PC-industry leader Dell is purely focused on operational excellence in everything it does. Therefore, it is very likely that IBM requires different services from its EMS providers than Sony, Apple or Dell does. Actually, Dell does even hardly use the services of EMS companies and has chosen to do the manufacturing itself. Being an operational excellent company, Dell knows itself how to produce against low costs, and therefore cheap manufacturing is one of its core competences. This way it does not have to share margins with a contract manufacturer [63]. Dell's business model of customer specific products (which are build with an Assemble-to-Order (ATO) policy – see also Appendix 2) – and which corresponds with the Customer Intimacy focus as shown in Figure 4.1, does not automatically make it a customer intimate company; main driver for the ATO policy is the reduction of costs.

Making the choice for one value discipline is not always that easy for an EMS. Sometimes, they are simply forced into a position due to the supply chain they are operating in. Sometimes the products they produce have their influence as well, as is clearly illustrated in example 4.2.

Neways [u23] and Omron [u25] are among some of the smaller companies studied, and both are examples of companies that focus on aspects of customer intimacy in their operations. They are more flexible in their operations than companies such as Flextronics and Elcoteq, and really try to involve the OEMs they work with. The larger EMS's (in this study Elcoteq [u12] and Flextronics [u15]) are more focused on operational excellence. Interesting development is that many companies start with collaborative design initiatives. Generally, both OEMs and part suppliers (so an EMS's suppliers and customers) are involved. Drivers are lower costs, better products, and time-to-market aspects.

Example 4.2 – Different value disciplines within the same EMS organization

In general, an EMS consists of different locations and plants. As some of the examples from the literature illustrate [83], it may be very well possible that one plant is better suited for customer intimacy and another better for operational excellence. A third plant can than excel in product leadership. This can especially happen to larger EMS companies, which are facing such diverse situations. The focus on a specific value discipline therefore may differ per plant, (OEM) customer or even per product, which relies upon the requests from the customer.

A product can request a product leadership strategy at product introduction, the first phase of its life cycle, but it might request an operational excellence strategy when it matures. This can result in shifting the production from one plant to another, or even from one EMS to another EMS. *Solectron* followed this strategy for the *Nortel* 450 Network Switch it produced some years ago. The product was first build in Austin, Texas. Later production switched to Guadalajara, Mexico. For more details see [83].

4.5 – Summary

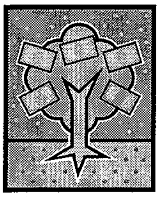
Customer intimacy, product leadership, and operational excellence are three different disciplines wherein companies can differentiate themselves from competition. It is shown that companies need to choose a single focus which then results in delivering their customers either the best tailored solution, the best product or the lowest costs. However, focusing on one of the value disciplines does not mean that the company can ignore the other disciplines; it still needs to meet industry standards in the others.

In today's Electronics industry, EMS's find their reasons for existing in their structurally lower manufacturing costs than its OEM customers. By nature, the EMS is a pure specialist in *operational excellence*. Nevertheless, this does not automatically translate in a solely focus on operational excellence. To differentiate itself from other EMS companies, an EMS can chose to focus more on one of the other two disciplines.

The *operational excellence* strategy translates in a pure focus on the production, logistics and procurement processes. An EMS that tries to become more *customer intimate* adds sales and service processes to this palette, and one that goes for *product leadership* focuses more specifically on design.

The latter part of the chapter showed that it is not always a choice. The position in a supply chain with dominant OEMs or suppliers can simply coerce an EMS in a certain strategy. Next to that, different phases in a product's lifecycle can have their influence on strategy as well.

Part II – Collaborative Processes



Part II – Collaborative Processes

The different aspects discussed in the first part, function as the foundation for Part II on Collaborative Processes.

A framework with two axis is introduced, with the three value disciplines on one axis, and the nine business functions on the other. This leads to the identification of different areas interesting for collaboration with supply chain partners. Furthermore, the influence of three different planning levels is addressed.

Chapter 5 – Collaboration Framework

This chapter focuses on supply chain functions that could be performed collaborative with supply chain partners. All theory and ideas from the previous chapters are merged and integrated with each other and function as the basis for an analysis. This analysis provides insights, and delivers some solution areas. These solution areas will be further detailed in Chapter 7.

5.1 – Functions performed collaborative

In Part I background information was given on the Electronics industry and its business drivers, Value Discipline thinking, and the theme Supply Chain Management. Chapter 2 clarified that a supply chain needs to perform certain functions, what does not automatically result into all partners fulfilling all separate tasks. It is very well possible that different partners specialize in some of these functions, and perform them for the others. The overview of the Electronics industry showed that this is not only theoretically true, is common practice. Contract manufacturers for example, take over the manufacturing functions more-and-more, and have specialized in production and logistics and (more recently) also in procurement (see Chapter 4). The value discipline theory shows that the specialization in certain functions is a logical result of the company's strategy.

Functions cannot only be divided between different partners in a supply chain, sometimes it is even better to collaborate and cooperate with partners in (some of) the functions itself. However, the drivers for collaboration depend largely upon the value discipline that is in charge. Under an operational excellence policy everything is solely focused on cost reductions, a product leader is continually striving to improve and re-new its products, and a customer intimate company positions its customer number one, and builds its business around it. Example 5.1 gives a description of the differences between collaborative design for the different value disciplines. Differences may be in the importance and prioritization of a certain collaborative process, or in the collaborative process itself: it may be performed and executed differently since its objectives differ.

Example 5.1 – Collaborative design for outsourced manufacturing

Collaborative design means that two (or more) companies collaborate together in the process of designing a new, or improved, product. This can be beneficial from different points-of-view: the end result could be less costly to manufacture, of better quality, more state-of-the-art, or more quickly available in the market.

Analysis (see the later Sections in this Chapter) showed that the benefits for an Electronics industry's company (i.e. an Electronics Manufacturing Services provider (EMS)) with a focus on operational excellence lay in design improvements such as a better *design-for-manufacturability*, and *design-for-testability*. When the focus is on customer intimacy, the driving forces for collaborative design are in the *customizability* of the product and a coupling with *customer lifecycle management*. A focus on product leadership tries to *handle complexity* and to improve *time-to-market* and New Product Introduction (*NPI*). It shall be clear that these different objectives have their influence on the collaborative design process as such. This is visualized in Figure 5.1.

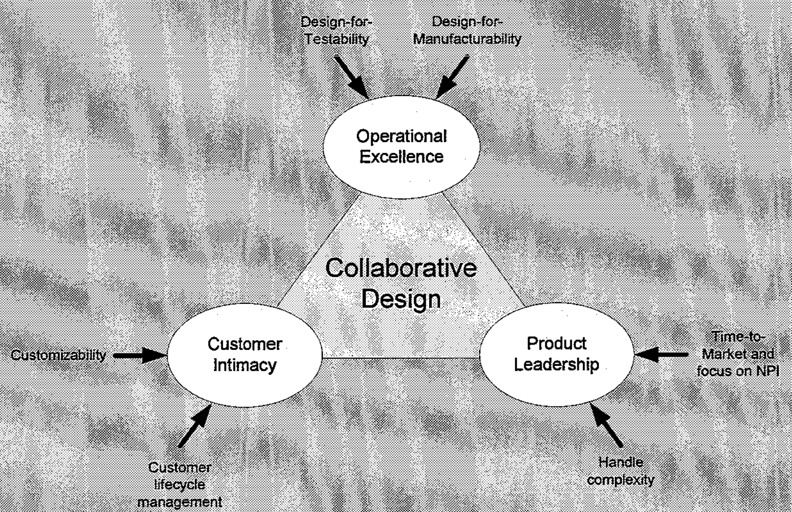


Figure 5.1 - The different objectives for collaborative design for an EMS

5.2 – Framework structure for collaborative processes

As this example for collaborative design shows, there is a large difference between the objectives for collaboration in a certain business function, due to the chosen value discipline. Ignoring the influence company-strategy has on a company's need for collaborative processes might perhaps be shortsighted, in practice hardly anyone includes this explicitly in their analysis. Deloitte Research [114], speaks nowhere about company strategies in its recent publication on collaboration in the Electronics. Although it defines certain areas as highly interesting for supply chain collaboration, with real impact on the bottom-line, nowhere does it recommend companies how to choose.

However, in this research project the concepts are combined. To identify the need for collaborative processes, it is necessary to combine business functions with business strategy, and to map this upon the business issues of manufacturing companies (i.e. the EMS and OEM (Original Equipment Manufacturer)) in the Electronics industry. The value disciplines are known, and the business functions can be well adopted from the earlier introduced SCM (Supply Chain Management) model (see Figure 2.1).

The concept of a simple matrix structure, which forms the basis for the analysis and mapping, is shown in Figure 5.2. On the horizontal axis it shows the three value disciplines. The vertical axis shows the nine business functions to perform.

Note that this figure includes two special area types: The gray part is the area Deloitte Research [114] defined as most beneficial collaborative functions. The striped part shows the core processes for an Electronics company with a certain value discipline focus, adopted from Chapter 4 of this report. These ideas are integrated here, since they give some basic insights in possible interesting areas that could require collaborative solutions.

Value Discipline / *Function*	Product leadership	Operational excellence	Customer intimacy
Marketing			
R&D			
Forecasting			
Procurement			
Production			
Logistics			
Sales			
Service			
Finance			

Figure 5.2 – Matrix structure for collaboration analysis

5.3 – The analysis

In Appendix 7 the matrix used in the real analysis can be found, it is in practice a larger version of the basic matrix introduced here, but filled with information. The two special areas just mentioned, functioned as starting hypotheses for the analysis. Feedback from experts, literature study, industry knowledge, and the previous part of the report, were valuable input for this analysis.

Some of the results of the analysis (see Appendix 7) can be found in Figure 5.3. The matrix shows five hotspots, or solution areas, where collaboration can be beneficial for manufacturers in the Electronics industry, i.e. from the standpoint of an EMS company. Prioritization of the solutions differs depending upon the value discipline chosen. These solutions will be referred to, from now on, as:

(1) Collaborative design for innovative products
(2) Collaborative design for optimal production
(3) Collaborative planning & visibility
(4) Collaborative order fulfillment planning
(5) Collaborative customer service

Some of these solutions span different (collaborative) functions, since it seems to be interesting to inter-connect these functions – however, it is possible as well to only collaborate on the separate function. This report uses the solution areas, since there are some interesting benefits to connect for example R&D (Research and Development) with marketing (in the design process), sales with service (regarding customer service) and middle-longtime planning decisions in the procurement, production, logistics and sales domains.

Solution 1, 5, and partly 4, are logically positioned in the areas where collaborative solutions are expected, due to the theory. Solution 2, 3 and 4 however, are not expected. The analysis turned out that collaborative design is an essential element for operational excellent companies as well, because of the simple fact that about 75% of a product's costs are linked to the original design. The first area to lower costs, is therefore the design phase. Collaborative planning and forecasting is already largely recognized as an interesting area for collaboration. So far it is mostly applied in the retail domain, and not really in industries such as the Electronics [88]. However, it seems to be an interesting area for collaboration for Electronics manufacturers as well, i.e. in connection with the procurement function, since it reduces uncertainty in the supply chain and reduces the likelihood of 'gaming'. Solution 4 seems to be a solution that is not only needed in the operational excellence domain, but also in the domain of customer intimacy. Although the objectives of both disciplines do differ, a flexible planning of the fulfillment network could benefit all. These three solutions will be further detailed in Chapter 7, as is the case for the other two solutions. Chapter 6 first takes a look at the differences planning levels bring. An essential element to know, before the separate solutions will be described in more detail.

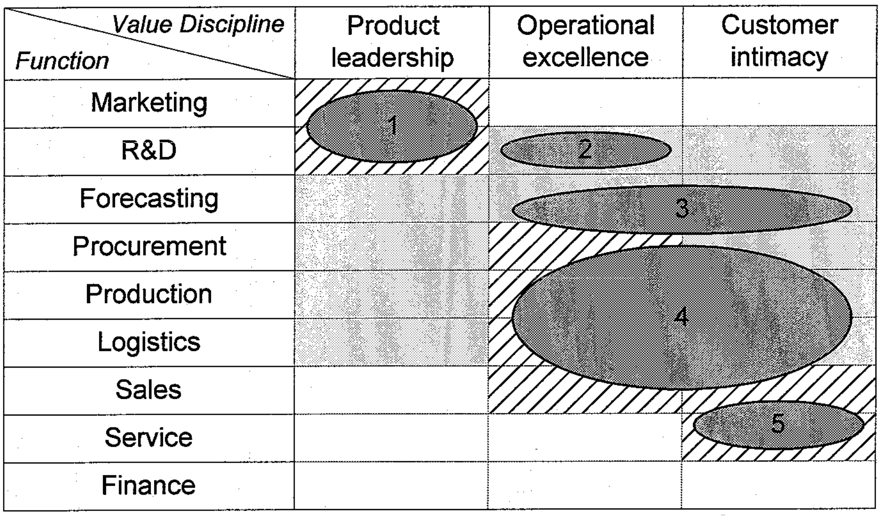


Figure 5.3 – Matrix structure with results of collaboration analysis

5.4 - Summary

Certain supply chain functions are candidates for collaboration with network partners. The drivers largely depend upon the value discipline in charge, and therefore the prioritization and the collaborative process itself vary with the value discipline and a company's role and position in the supply chain. Collaborative design, for example, turns out to be very valuable for Electronics manufacturing companies with an operational excellence, or a product leadership focus, but less for companies that are customer intimate. The drivers for this process do differ, and therefore it seems to be logical that the solution differs as well.

A matrix framework is suggested as the basic structure for an analysis. One axis shows the three different value disciplines, the other axis shows the nine supply chain functions, as defined in Chapter 2.

Analysis shows that there are roughly five areas, which are interesting for supply chain collaboration. These areas do – as expected – largely depend upon the chosen strategy. The solution areas are: (1) Collaborative design for innovative products, (2) Collaborative design for optimal production, (3) Collaborative planning & visibility, (4) Collaborative order fulfillment planning, and (5) Collaborative customer service.

Each solution will be further detailed in Chapter 7.

Chapter 6 – Planning Level and Decisions

Three different planning levels (operational, tactical, strategic) are the subject of this chapter, in where it is shown that all decisions for each business function in an enterprise are taken at one of these levels. Everything will be assembled in a matrix-style framework. Next to that, inter-company communication and the relationships between the different matrix crossings are addressed. The last section of this chapter focuses on the cost impact of the different planning levels.

6.1 – Planning level framework

In an organization as well as a supply network, decisions are usually classified as strategic, tactical, or operational [58]. Strategic decisions are usually linked with the company's corporate strategy, and guide the design of the supply network. They are typically taken over a long period of time (2-5 years, or even more). Tactical decisions are taken on a monthly to annual basis, whereas operational decisions are short-term, and directly affect day-to-day activities.

Previous research [68] suggested a layered information exchange in order to communicate with suppliers in the procurement area. However, so far this idea was never combined with Supply Chain Management (SCM) thinking, and assembled into a conceptual framework. Figure 6.1 shows the framework based upon these ideas. Companies face decisions to make in different domains, such as marketing, R&D, and forecasting. The decisions need to be taken at different planning levels. In this figure, each crossing corresponds with a set of business processes a company needs to perform.

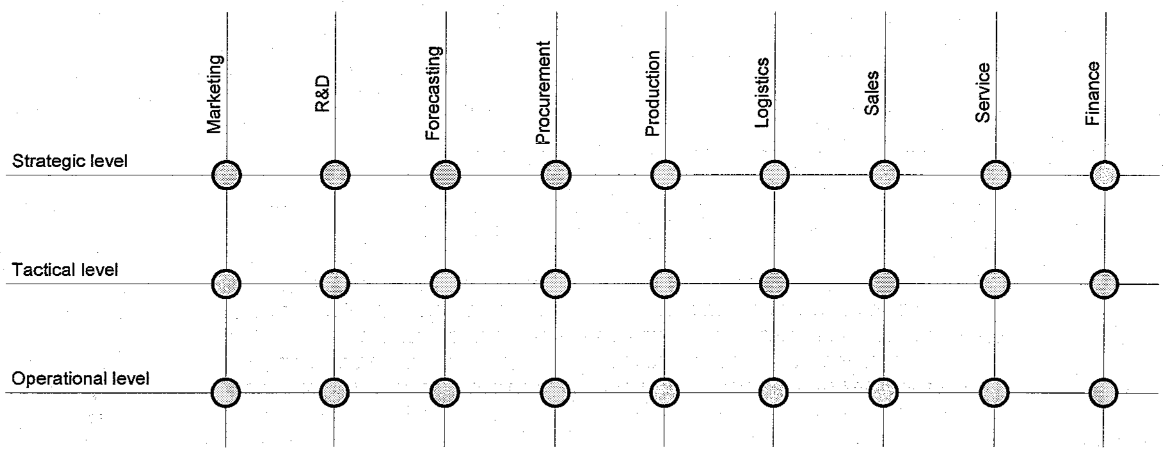


Figure 6.1 – Layered process framework

Different planning levels ask for different optimization approaches. Generally speaking it may be stated that the characteristics of the different optimization decisions are:

- At the **strategic** level, the complete design (of product, network or relationships) can be optimized.
- At the **tactical** level, the optimization takes place between the boundaries as set in previous decisions.
- At the **operational** level, time lacks for real optimization, and therefore optimization is focused on optimal resolution of emergency operations when they occur.

6.2 – Decision taking

Table 6.1 gives an illustration of the different optimization decisions to take at the three planning levels in the nine functional domains.

Table 6.1 – Decisions in different domains at different planning levels

Function	**Decision taking at different planning levels**		
	Strategic level	*Tactical level*	*Operational level*
Marketing	Set long-term product strategy; arrange partner contracts	Capture market requirements; new product introduction	Collect market feedback; execute marketing campaigns
R&D	Long-term research; new product design	Execute research projects; design improved products	Monitor product performance
Forecasting	Fit company situation with expectations	Integrate partner input; analyze information	Monitor trends
Procurement	Choosing suppliers, long term contracts vs. short term deals	Type and quantity of raw material to be purchased	Date, time and location of arrival
Production	Factory locations, product lines, proximity to end customer	Allocating resources	Scheduling production
Logistics	Setting up transportation network, outsourcing vs. in-house function, warehouse locations	Planning optimal routes for trucks	Loading / unloading operations, bookkeeping
Sales	Demand forecasting, special promotions	Order fulfillment	Order status information; expert feedback
Service	Design service organization; integrate service in organization and products	Manage field services, customer complaints, and warranties	Support customers
Finance	High-level accounting	Analyze financial performance information	Manage operational financial flows

6.3 – Inter-company communication

The framework does not only provide insight into the day-to-day business of one single company, it has also a connection with collaborative relationships, and inter-company communication.

In simple, non-collaborative relationships communication between two business partners hardly exceeds the operational level: incidental transactions. When collaborative relationships with suppliers, customers or even competitors move beyond incidental transactions, communication at higher (planning) levels (strategic and tactical) becomes crucial [68]. Decisions taken together with these partners make it possible to optimize the day-to-day processes and to ease the communication at lower levels. Note for example the difference between a purchase order (with full details) and a call-off order. Furthermore, it is expected that the collaborative efforts at the different planning levels have their influence on the relationships of the partners itself as well [14].

Communication between different processes of separate business partners are generally performed at the same planning level [68], see Figure 6.2 for an illustration, which means that a strategic decision does not inter-link with an operational decision of a business partner.

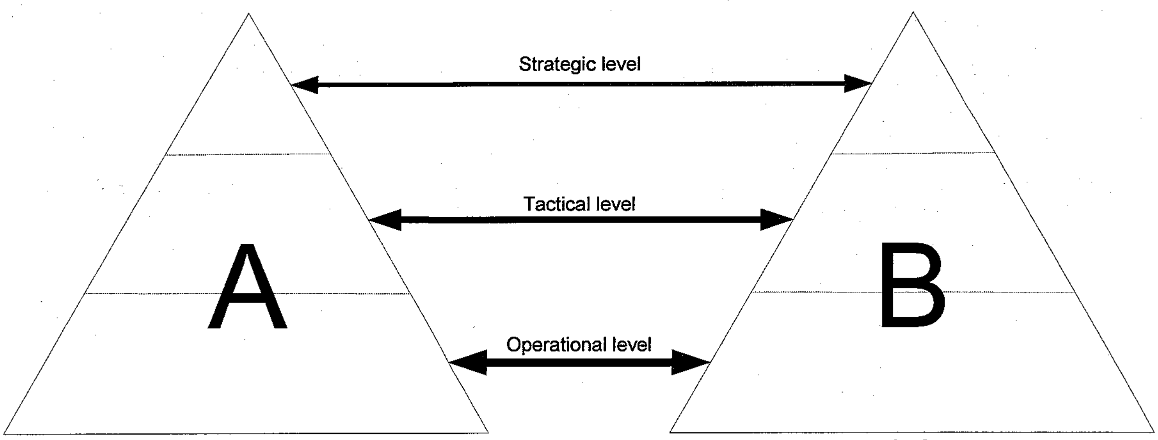


Figure 6.2 – Communication at different planning levels between supply chain partners

6.4 – Connected processes

There is a relationship between the different crossings in the framework. Figure 6.3 shows that it is expected that each dot, will have a direct connection with other dots via both the horizontal as the vertical axis. It is less likely that process relationships exist via some diagonal axis.

Example 6.1 shows some of the possible connections between different processes from this figure.

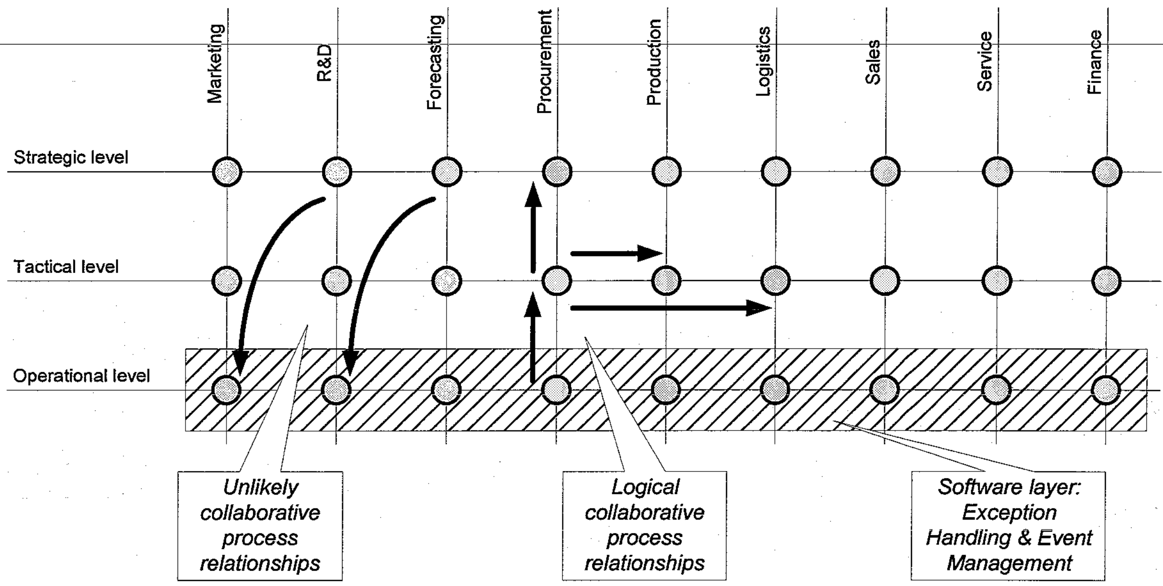


Figure 6.3 – Process connections

Example 6.1 – Examples of possible process connections

Examples of process connections are:

- The strategic level: The *R&D(Research and Development)* and *procurement* domains could interact in the design process of new products where the use of different purchasing parts is considered.
- The tactical level: The *procurement* and *production* planning domains interact when, due to an unexpected large demand, buy/make decisions need to be taken at the tactical level. To temporarily fulfill, the high demand.
- The operational level: The *sales* and *production* domains are likely to interact when sales wants to enter a rush-order. It is needed to link with production planning, and to weigh the different options.

6.5 – Planning level impact on collaborative processes

So far, three different aspects are presented which have their influence on collaborative processes; value discipline thinking, business functions, and the planning levels (see Figure 6.4 for an illustration). This figure shows how everything relates. The planning level and value disciplines both have their influence on the way the business function is performed, the '*what*', on which the collaborative process depends, the '*how*'. All ideas are combined in the detailing of the separate processes as can be found in Chapter 7.

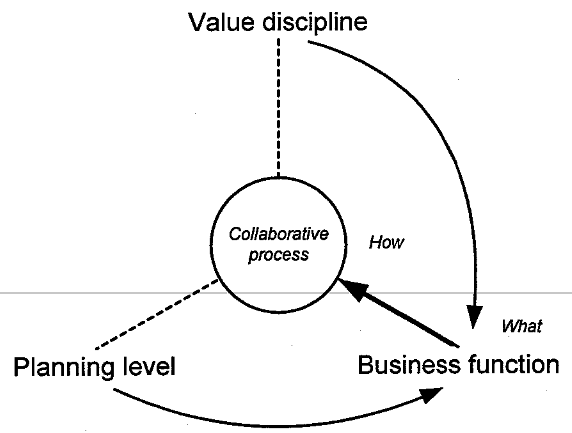


Figure 6.4 – Three aspects and their influence on collaborative processes

6.6 – Summary

Each decision a company has to take – in anyone of the nine supply chain functions – is either a strategic, tactical or operational decision. Strategic decisions guide the design of the network, product or relationship. Tactical decisions try to optimize between the borders that are set, and operational decisions generally are event-based responses (i.e. resolution of emergency situations, etc.).

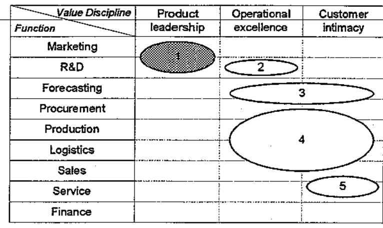
Combining the planning level concept with the nine supply chain functions delivers a framework which is useful to analyze how separate functions integrate with each other, to see how supply chain partners interconnect and to learn about common (software) functionalities per layer, the latter is addressed in more detail in Part III of this report. Furthermore it is shown that planning levels also influence collaborative processes. To keep it simple, this theory was left out of the analysis performed in the last chapter. The detailed description of the separate processes, in the next chapter, however will use it.

Chapter 7 – Collaborative Processes

This chapter provides a brief overview of the solution areas identified in Chapter 5. Combined with the ideas on the planning level influence from Chapter 6, these ideas are addressed in more detail in this chapter.

7.1 – Collaborative design for innovative products

7.1.1 – The solution area



Collaborative design is the process of designing new products together with suppliers and/or customers. Involvement of supply network partners in the product development phase is beneficial in two main areas [124]: development efficiency and effectiveness. In terms of *efficiency*, supplier involvement can lead to the reduction of development costs and the reduction of development lead-time. In terms of *effectiveness*, supplier involvement may lead to the reduction of product cost, the increase of product value and a shorter time-to-market.

Collaborative design is not only identified through this research as an interesting area for collaboration, others, see for example [1], [114], [124], recognize its potential as well.

Especially for Electronics' companies (e.g. Electronics Manufacturing Services (EMS) companies) with a product leadership focus collaborative design is essential, since they need to operate with state-of-the-art technology, with time-to-market pressures, and continuing new product introductions (NPI) (for more information about NPI steps see [83]). Time reductions in all its aspects – results of both development efficiency and development effectiveness (see above) – are very important issues with such a strategy.

Time-to-market pressures require product leaders to develop their products as fast as possible, to get it to market quickly [3], [95]. Different specialists from different supply chain partners across locations work together on new products, herein manufacturing and service organizations play a role as well. There is a focus on NPIs, and a need to prepare for the roll out phase. Companies that deliver state-of-the-art technology are always facing the challenge of complexity. Knowledge sharing gets very important since this is an instrument to overcome this complexity.

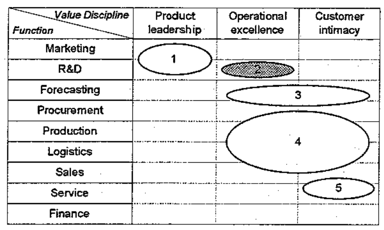
For such companies, R&D (Research and Development) and design are never-ending stories. It is the fundamental key to business, which is not only displayed in collaborative product designs, but also in state-of-the-art joint research projects where OEMs (Original Equipment Manufacturers), EMS companies and perhaps even parts suppliers are involved.

7.1.2 – Planning level influence

From a planning level perspective the decisions will generally be of the *strategic* and *tactical* type, although it also touches very *operational* things such as engineering changes. The work for product leaders is absolutely on the edge, and the design of the best, or most state-of-the-art, products is the key that drives the business.

7.2 – Collaborative design for optimal production

7.2.1 – The solution area



Collaborative design for companies with an operational excellence strategy is much more focused upon the cost benefits that can be achieved through partner involvement in the design process, and less on the time aspects. The past section already showed that both an efficient as an effective design translate into cost-reductions. The reasons are diverse, but in generally caused by the gap between those who design (e.g. the OEM) and those who produce (e.g. the EMS). Tighter coupling of design and manufacturing can result in cost savings and more efficient production techniques. Note that about 75% of the costs of a product are linked to the original design [28], [83].

Integrating feedback from the (EMS) factory floor and making use of the supply chain and operational knowledge from the EMS can bring large improvements in the design of new products. It ensures that the manufacturing and supply chain experiences of the EMS provider are reflected in the product.

Some examples are:

- Direct feedback from the factory floor can result in designs that are easier to manufacture and/or easier to test. This is described as Design-for-Manufacturability (DFM) and Design-for-Testing (DFT).
- Integrating knowledge around the right materials to use can be beneficial as well. Knowing which parts will become obsolete soon, or which parts cannot be combined with other parts, or under which conditions alternatives might be used can be of good help.
- Economies of scale – for example by recommending a part that is also used for another OEM customer – might benefit the design, simply because it influences the final product's costs.

This is evident for new product designs, but it also applies to design enhancements during the lifecycle of the product. Nevertheless, the processes do differ, and part of the design process can be designing the physical supply chain.

Although there is no wide application of collaborative design in industry as of today [1], several EMS companies are aware of its benefits and have begun to experiment in this field. Some of these companies are driven by the fact that they took over production facilities from OEMs, which included engineering divisions. Others realized the true benefits and therefore set up joint processes with their supply chain partners.

Although collaborative design starts with the intention to work (and improve) together, enterprise software support can smooth and optimize the process. One large problem this type of process solutions face, is the fact that it is much harder to justify investments based on cost avoidance rather than on cost reductions, since it is difficult to make a financial case by comparing against 'what might have been' [1].

7.2.2 – Planning level influence

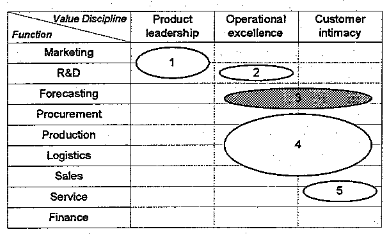
The decision processes in the collaborative design concept for operational excellence are mostly *tactical*, and less strategic than in collaborative design for product leaders. Generally speaking, the EMS has no real influence in the strategic development direction of products, that remains controlled by the OEM, but it has some influence regarding detail aspects, such as the chip layout, and the usage of certain components, but after the high-level design is made already.

In the original design phase, teams from the different companies work together for several weeks, with the purpose to boost a design's quality and to reduce the costs that are incorporated in the design.

In the design enhancement phase the EMS is the driver. Feedbacks from the production floor and market developments (i.e. in the parts-market) do trigger this. This process is less structured and more spontaneous – with tactical and operational aspects.

7.3 – Collaborative Planning & Visibility

7.3.1 – The solution area



Collaboration in the forecasting and procurement planning domains was early recognized as an interesting area for collaboration, see [88]. Sharing demand and goods flow information in the supply chain, and performing the planning process in a collaborative manner, boost the performance of the supply chain. It reduces uncertainty, and increases the visibility of good and demand flows, which together can tackle many of today's supply chain problems, such as 'gaming', the bullwhip-effect, some of the problems of obsolescence, etcetera.

The case studies at Neways and Omron provided the insight that the need for visibility and collaborative planning exists very widely. In multi-site situations it is needed to oversee the inventory status at the different plants. That way, a warehouse-shipment between two own locations can safe an extra order for the same material at one of these locations, and leaving the other location with extra stock (which may become obsolete soon). Another, even more stringent, example is the visibility of good flows. Material gets ordered, an order notification is sent and received, and a delivery date promised. However, it is very important for further planning purposes (i.e. warehouse planning, shop floor scheduling, etc.) that order statuses get updated regularly, and that changes in delivery schedules are communicated and recognized anytime soon. Some interesting examples of collaborative planning & visibility could be found in [57] and [88].

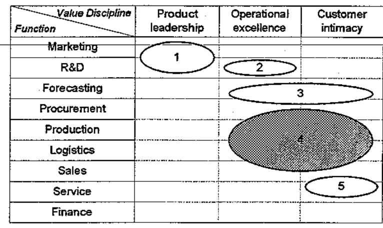
Collaboration between network partners (and large network within the own enterprise) in the forecasting and planning processes can bring large benefits; it tackles almost all issues as raised in the later part of Chapter 3.

7.3.2 – Planning level influence

Collaborative planning and visibility spans all planning levels (strategic, tactical and operational), although it mostly influences the *tactical* and *operational* planning decisions. Visibility is especially essential at the operational level, and planning processes where partners together decide upon the forecast and planning are more tactical and sometimes even strategic.

7.4 – Collaborative Order Fulfillment Planning

7.4.1 – Introduction to the concept



The ideas behind *Collaborative Order Fulfillment Planning* can be best explained by first looking at an example from a completely different industry. Li & Fung [25], [78] is Hong Kong's largest export trading company, active in clothing and other consumer goods ranging from toys to fashion accessories to luggage. Originally founded as a buying agent (in 1906), the company transformed into a supply chain manager / network orchestrator. The company is no longer active in manufacturing itself, but manages a network of 7,500 suppliers in more than 39 countries (mainly in Asia) with on average 200 employees each. Li & Fung's target in working with factories is to take anywhere from 30% to 70% of their production. At least 30%, because they want to be important as a customer. On the other hand, 70% at most, since flexibility is needed and they do not want a company to be completely dependent on them.

As [78] shows, Li & Fung tries to do all high-value added activities itself, and organizes all other (lower-value added) activities with partners. This way Li & Fung is not only very flexible and capable to make use of the advantages different countries offer (such as knowledge, cost structures, tax rates, and quality related issues), but more important, its human planners are capable to optimize the network based upon the real-time statuses and capabilities of the different partners. An order does not follow a predefined route anymore, neither does it follow the route the last order did, but it does get planned and optimized at the moment it is captured. This may bring large benefits since network wide optimization happens, based upon factors such as capacity, costs, profits, speed, and/or any other constraints.

In this Li & Fung case study, knowledge workers are key in the definition process of the individual order fulfillment plans. Basic idea behind their business concept is a flexible network that is always dynamically planned and assembled depending upon the order that arrives. Why won't something like this work in the Electronics industry, and why won't there be a smart role for enterprise information systems in this kind of business models?

As previous chapters of this report showed, the Electronics industry is increasingly depend upon outsourcing. One of the main issues of outsourcing is the greater competitive flexibility it creates. While fixed cost investments in physical- and human-capital are limited, it is relatively easy to switch outsource partners. The market leaders of tomorrow might be the companies that master how to frequently assemble and adapt their supply chains to changing customer needs and new supply chain opportunities [61]. Reassembling supply chains can mean that new partners get involved, but it can also mean that the supply chain structure changes, without changing partners. The route is different, and optimized on an overall level. Companies will make use of real-time, cross-enterprise information to determine the most efficient way to deliver a product to the customer [81].

Other literature gives some more long-term vision models, which show a large similarity. See for example [23], [69], [71], and [90].

7.4.2 – The solution area

Especially for companies with an operational excellence or customer intimacy focus, sales and purchasing becomes very important. In case a company masters these aspects it is better suited to operate at low costs, or match the exact customer requirements. When starting to think in a collaborative manner, sales and purchasing become even closer related than they already used to be. A sales order directly triggers a purchase process [71] and companies are no longer seeking to optimize only their own company situation. Optimization of the whole supply chain network might be a better choice. Perhaps it is time to introduce collaborative order fulfillment planning?

The Electronics industry's landscape might look slightly different in a few years. An order does not follow a predefined route anymore, neither does it follow the route the last order did, but it does get planned and optimized at the moment it is captured; see Figure 7.1. This brings large benefits when optimization happens based upon capacity, costs, profits, speed, and other constraints.

Collaborative order fulfillment planning helps to take more optimal production decisions, and so it realizes cost savings. The decisions taken are based upon the capacities, utilization, and costs in the complete network. Optimization in the fulfillment planning process is done for the complete supply chain network instead of local optimization of the individual parts of the chain. This process involves suppliers, and sometimes even the suppliers' suppliers, and it includes the different plants of the EMS itself. On the other side of the network the OEM, the channel partners and the third party logistics (3PL) providers might be integrated as well.

The process starts with a request from the customer (i.e. the OEM or the end-customer). Based upon this request the collaborative order fulfillment planning solution checks the different ways the product can be built and routed. As pointed out before, the same end-product can sometimes be assembled via different bill-of-materials (BOMs) – see also Appendix 5. Making the right decisions here, in respect to costs and availability, can result in huge financial savings. Furthermore it can be beneficial to plan the fulfillment process network wide. Choices for the different suppliers, delivery terms, and production locations can be based upon issues related to capacity, related costs, utilization rates, distances, time related issues, etcetera. The main questions to answer and optimize are what, where, how and when to produce, and how and when to deliver. See Figure 7.2 for an illustration.

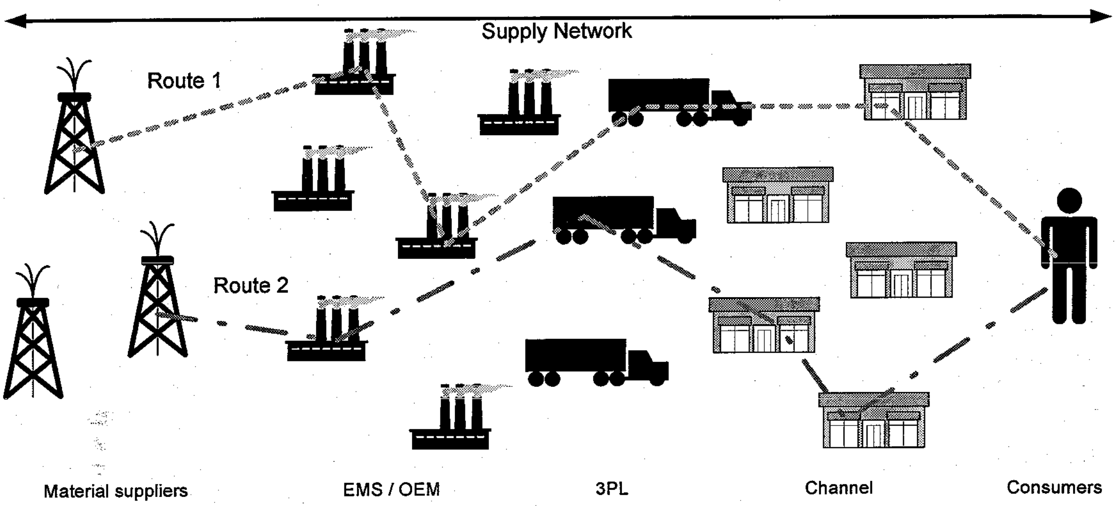


Figure 7.1 – Dynamic network routing

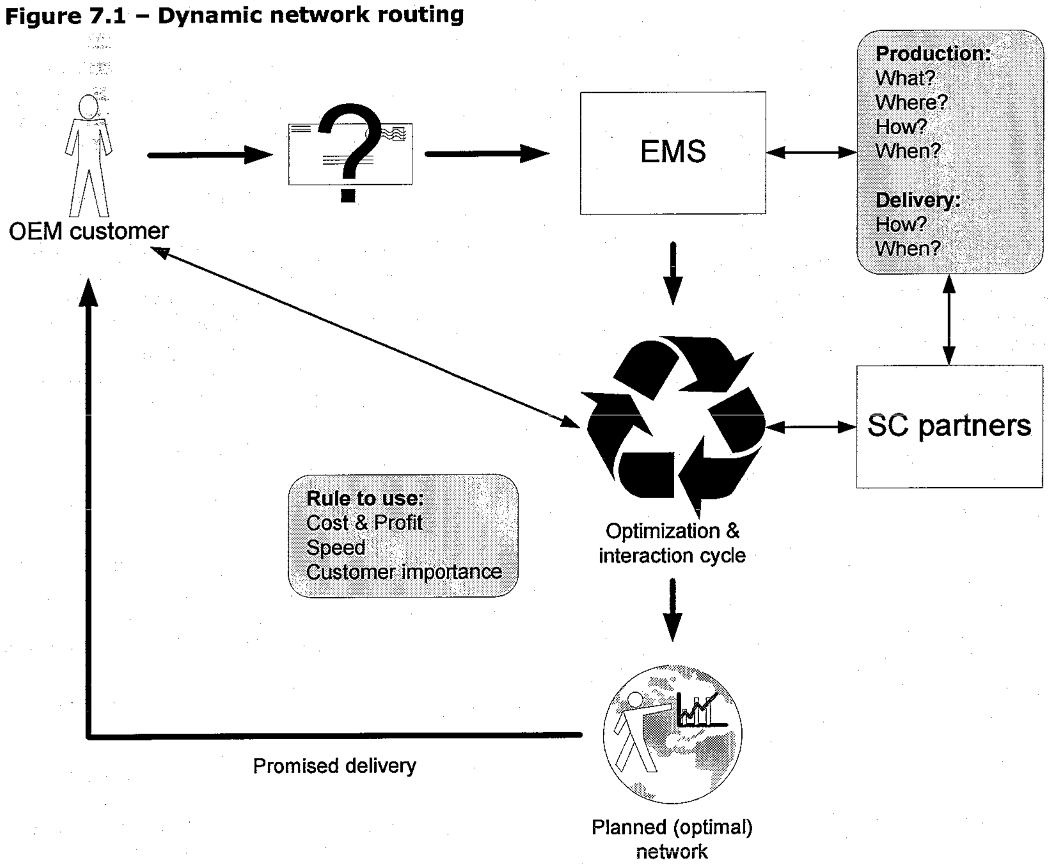


Figure 7.2 – Collaborative order fulfillment planning

At first glance collaborative order fulfillment planning may look like an extension to normal order promising processes, where Available-to-Promise (ATP) and Capable-to-Promise (CTP) calculations deliver insight in production and delivery capabilities. However, this goes way beyond that. The focus is network wide, which means cross-enterprise, instead of an enterprise or even plant-centric view. Furthermore, it includes distribution issues (see also [87]). Last, but not least, it also takes issues related to multiple children BOMs into account. Altogether, the planning will be much better suited to boost the overall network performance capabilities. This process can be used for another optimization-round, in case the situation changed and plans need to be updated. Preferably the operator is alerted (if needed), and guided through the resolution process in where a choice can be made from different alternatives, which are already generated.

Automatic optimization of fulfillment decisions and the network-wide CTP capabilities support production postponement and a shift towards make-to-order environments [3]. The customer plays an important role in the whole process and can have part in a (partly automatic) negotiation process.

7.4.3 – Planning level influence

The collaborative order fulfillment planning process is purely focused upon *tactical* decisions: (re)optimize within the given borders and generate the most beneficial order fulfillment planning. When later re-optimization happens it may be well possible that the *operational* planning is touched as well, in that case an intelligent event management, and workflow guidance is necessary to help the operator.

7.4.4 – Baby steps

It is perhaps not realistic to introduce and position the collaborative order fulfillment planning in the same manner as the other collaborative processes described in this chapter. Although the introduced concept seems to be very promising, it will not be easy to achieve. There is a long way to go for the companies before they can achieve a situation where collaborative order fulfillment planning will be part of the everyday business. Relationships between companies have to change, processes and procedures to be adjusted, and the enterprise software vendors cannot provide solutions off the shelf right now.

The process of collaborative order fulfillment planning combines and optimizes different traditional functions within and between companies in the network. These functions include procurement, forecasting, production, sales, and logistics. Combined optimization is better, since for example logistical costs, play an important role in procurement decisions [3].

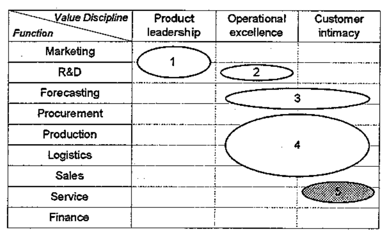
It may be more realistic to start with the development of (smaller) software solutions for these specific processes separately, instead of a direct overall approach. Collaborative order fulfillment planning may be seen as a combination of collaborative planning/forecasting and collaborative order management, as described by [114].

7.4.5 – Consumer Order Decoupling Point

Recent academic theory (see [67], [118]) suggests to move inventory to the end of supply chains, where the Consumer Order Decoupling Point can be found – see also Appendix 2. The individual companies in the supply chain network can easily reduce their inventory levels since inventories upstream do not really influence the (service-level) performance of the total network. The theory pleads for smarter ordering decisions, and defines ordering as a tactical or even strategic decision; since the moment an order is placed by a customer is always the result of the expected throughput time and delivery date. The collaborative order fulfillment planning concept, where an order is steered through the network as optimal as possible is absolutely inline with these concepts – both areas are interesting candidates for further (combined) research.

7.5 – Collaborative customer support

7.5.1 – The solution area



Customer support was traditionally an area for the company that was responsible for sales to the final customer (e.g. the OEM), and it will most likely remain one of the core competences of most of the OEMs, especially since it is one of the contact points with the customer [23]. Nevertheless, that does not hinder a larger role for EMS's in the process of customer service. Especially, considering the fact that as an EMS becomes more and more the owner of product knowledge, it is in a logical position to give support. EMS companies with their focus on customer intimacy might consider moving into the area of collaborative customer support.

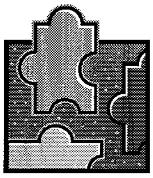
For each product, an EMS can store all related information. Information such as BOM used, production dates, suppliers used, etcetera, might play a vital role in the support process. Specific questions can be rerouted to the respective experts, and problems with the products can be discovered earlier.

Feedback from the market – about failures, problems, etcetera – gets back to the source sooner and may result in better products. It might be very useful, to let customers not only talk with company (or supply network) experts, but also with one another [100].

Note, that software becomes increasingly part of the products. It is a product feature that might result in product upgrades later in the products life, and it may solve problems that can occur. Especially for this kind of software (mostly referred to as embedded software) the knowledge from the source benefits the quality and velocity of a solution.

7.5.2 – Planning level influence

Giving customer support mainly is an *operational* process: right here, right now. Translating feedback from customers into product enhancements however, is more a *tactical* or even *strategic* process (in case a company uses the support information when designing new products).

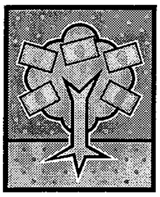


7.6 – Summary

All five-solution areas, which were identified in Chapter 5, are detailed in this Chapter. These solutions are: (1) Collaborative design for innovative products, (2) Collaborative design for optimal production, (3) Collaborative planning & visibility, (4) Collaborative order fulfillment planning, and (5) Collaborative customer service.

Each solution is detailed briefly, and some of the basic business and process issues are described. Note that each solution area is a candidate for further research.

Part III – Collaborative Software



Part III – Collaborative Software

It may be stated safely that software for collaborative environments is still in its early years, and that there is much to come. The chapters in this Part III are written from an Enterprise Resource Planning (ERP) point-of-view. It is not focused on the definition of whole new enterprise information system architectures, as a replacement for today's ERP systems. Rather it is focused on the identification of the functionality that is lacking in the environments as currently implemented, and to define an answer for tomorrow's challenges.

Struggle points are integration, smart automation, exception handling, and a good use of historical data. Knowing this, attention is paid towards Enterprise Integration, and a here-introduced concept referred to as the Proactive Resolution Broker.

Chapter 8 – Enterprise Software

This chapter gives a brief overview of both the history and current state of enterprise information systems in the industry, shows some major problems today's systems have, and list the pain-points that hinder collaboration in the supply chain.

8.1 – The history of Enterprise Information Systems

To obtain a better picture of today's enterprise information systems, and to track today's problems; the historical development of these systems is outlined briefly below. The reader is referred to [26] for a more detailed historical overview.

The first computation and data storage applications became available in the 1960s. Software was introduced and mainly used for simple calculations and data storage. Systems evolved, and in the 1970s, Material Requirements Planning (MRP) and Manufacturing Resource Planning (MRP-II) applications became available, due to the business need for a better-coordinated material flow. The evolution continued and in the 1980s the first Enterprise Resource Planning (ERP) applications were introduced, with some basic Workflow Management (WFM) functionality. In the 1990's companies started to look beyond their own corporate border, and started to open up their systems for supply chain partners, mostly through point-to-point Electronic Data Interchange (EDI) connections.

8.2 – Current Enterprise Information Systems

In today's practice Enterprise Information Systems are key of the business. Figure 8.1 provides a simplified view on today's software infrastructure (source: [117]). Note that the real software landscape is more diverse and complex.

Many companies have implemented an ERP backbone, or are in the process of implementing one. One of the main reasons for having an ERP system is to have consistent and integrated processes within the enterprise domain. ERP functions as the backbone for information storage, processing and transaction support.

Customer Relationship Management (CRM) systems deal with the customers, and Supplier Relationship Management (SRM) applications facilitate all contacts with suppliers. On top of all this Advanced Planning & Scheduling (APS) functionality tries to optimize all enterprise-wide decision making.

Over the last years, many companies have shown their interest in different integration initiatives. One aspect is the realization of a good integration of the different information systems in use in the same organization. So-called middleware solutions help to integrate different information systems and data sources, mainly within the corporate borders of the same enterprise. However, integration plays a role in the integration across multiple different organizations (the same enterprise, or supply chain partners) as well. There are different modes to achieve that, for example via user access via the web, or application-to-application integration, mostly referred to as Enterprise Application Integration (EAI).

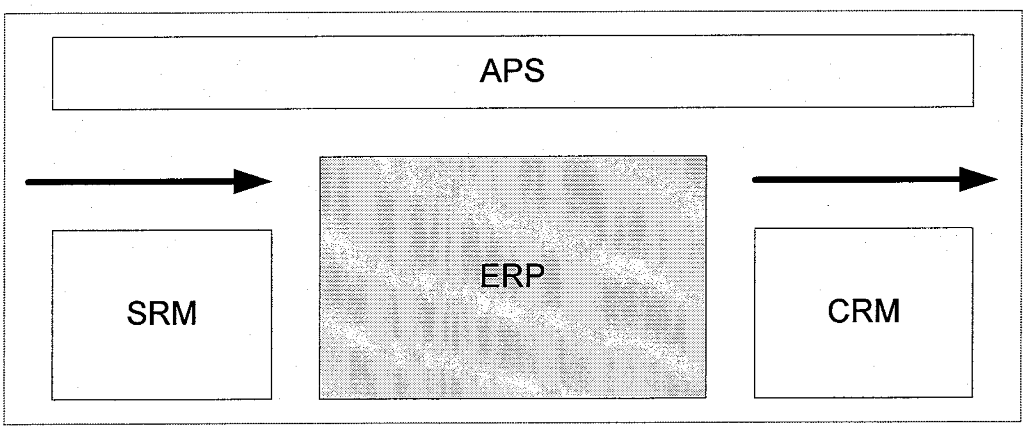


Figure 8.1 – Simplified architecture of Enterprise Information Systems

8.3 – Problems

Today's enterprise systems do have their problems, and there still is a challenging road ahead. Problems with today's ERP packages and enterprise suites are, according to [79], its limited functionality, lack of decision support, lack of extended enterprise support, implementation and upgrade difficulties, and high total cost of ownership [79]. There is a problem especially in the four-wall focus of these software packages: Optimization only takes place between corporate borders, and there is hardly any network optimization, or even information exchange, with partners. The added components, as shown in the figure, help to reduce this, but until now they do not enable true collaborative relationships. Furthermore, most systems (i.e. ERP) are driven by historical data (e.g. fixed parameters), and lack the flexibility to respond to inevitable discrete changes that are likely to occur [24].

Analysis of the collected company input (from Omron [u25], Neways [u23], Flextronics [u15], and Elcoteq [u12]) and examples from the Deloitte&Touche [u10] consultancy practice provides the insight that there are still some (technical) problems, which hinder today's enterprise information systems. They hinder today's systems, but can be a major issue for (future) more collaborative environments – in where partners are connected – as well:

- Information integration with business partners is still difficult.
- Tools to enable process integration with business partners are almost completely lacking.
- Visibility of information (such as stock levels, order status, lead-times, etc.) is generally lacking.
- Optimization over different links in the supply chain is hardly doable.
- Intelligent decision taking is not really the case. A user does not get notified upon events, and is not guided through the resolution process.
- Responses to events are re-active, instead of pro-active, or at least real-time.

8.4 – Planning level impact

8.4.1 – Impact on enterprise software

When thinking about ways to improve this, it is important to realize that the planning level concept, as introduced in Chapter 6, has its impact on enterprise software, as it has its impact on costs (see the next section). Each of the three levels in the framework has its own software requirements. Advanced information technology, with smart calculation and mathematical features, is needed at all levels. As is, for example, the use of historical data. However the application of software technology is very different. At the *operational* level advanced functionality is needed to cover exception monitoring, handling and resolution. Separate of the fact whether it is an operational sales decision, or an operational procurement decision. At the *tactical* level mathematical models can be used to optimize decisions, and again the difference is not that large between for example optimization of logistics and production. Optimization can be even performed combined, see for example Section 7.4. Simulation and use of the system dynamics theory are two examples to perform at the *strategic* level, where, as Section 6.1 did already show, the complete design of the environment (product design, network design, or relationships design) can be set. These approaches could help to define the optimal structures. Figure 6.2 does only show one specific layer – the exception handling layer – but as just stated, there are more. Most of the, in Section 8.3, listed problems relate to planning decisions of the operational or tactical type.

It is important to realize that almost all companies have their own enterprise information systems implemented. And, although the current systems are not well suited for collaborative commerce [79], they cannot be simply neglected. Today's systems (i.e. ERP) have a logical function as the starting point for new – more externally focused – initiatives, and functionality enhancements. Basis of thinking therefore needs to be the highly simplified landscape as illustrated in Figure 8.2.

The next chapters will address most of these issues. This research is not focused on the definition of a new architecture for ERP packages. The focus here is on the functionality needed. In Chapter 9 therefore, the focus is on Enterprise Integration, an important aspect since everything starts there. Chapter 10 envisions an interconnected model – for a layer of enabling technologies – that helps to address most of these issues, i.e. at the operational planning level. Issues that relate to performance variability, unplanned events and uncertainty, from now on referred to as the Proactive Resolution Broker.

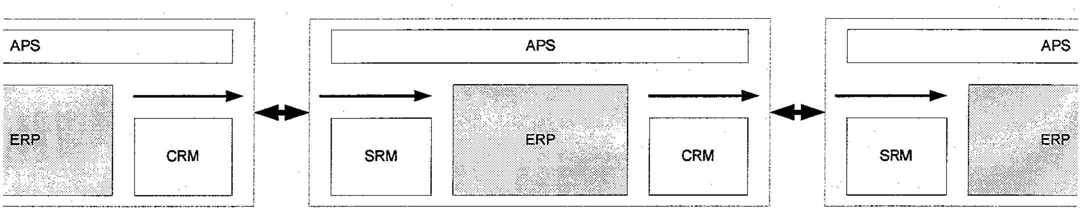


Figure 8.2 – Enterprise Information Systems in a supply chain

8.4.2 – Cost impact

The planning levels have their influence on costs as well. Optimization at the operational level is likely to result in a reduction of the *transaction overhead costs* (see Section 2.6). Optimization at the tactical or strategic level are likely to result in a reduction of especially the *non-coordination costs* and some strategic decisions may even influence *core costs*.

Generally speaking, strategic decisions have greater impact on cost savings than operational decisions have. The Return-on-Investment (ROI) is larger [2]. Knowing this, it would be logical to devote the major part of the available human capital in a company to the more strategic decision processes. However, today that is not the practice. Information technology could help to automate the more routine tasks and decision making at the operational level, while supporting the knowledge workers to make the right decisions. Good strategic processes start with good operational processes; which pleads for a good support and automation of these operational processes through the use of information systems. Figure 8.3 illustrates this in one single image. Note that the number of transactions would show a mirrored line in the figure – far more operational transactions are present (and needed) than transactions at the strategic level. Thus making it logical that enterprise information systems support these processes. This knowledge should be an important aspect for the design of new enterprise information systems.

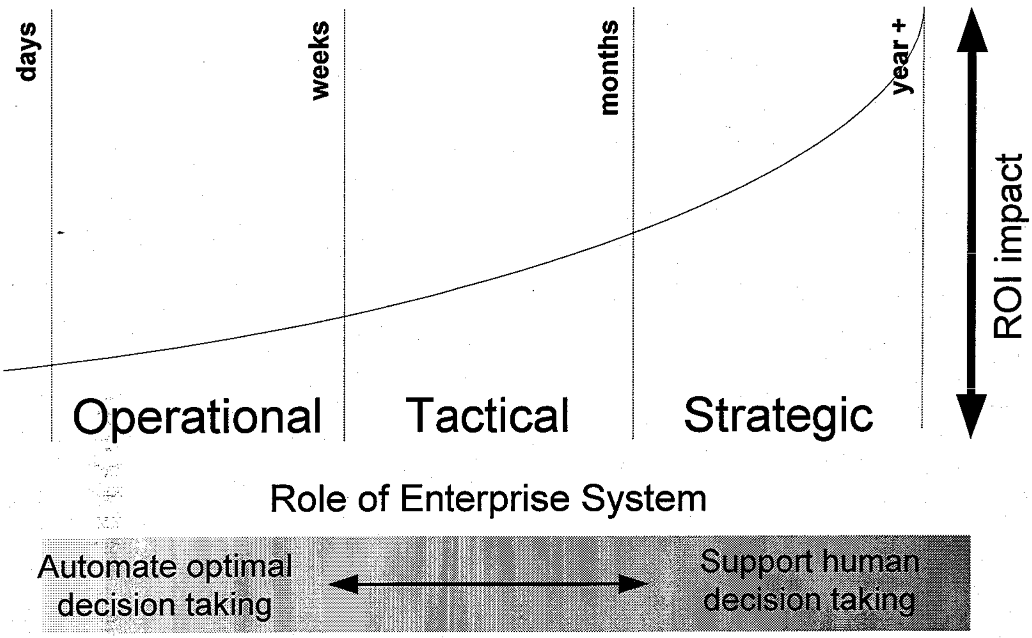
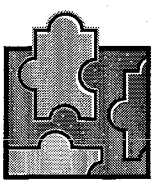


Figure 8.3 – Planning levels, ROI impact and the role of Enterprise Systems



8.5 – Summary

Computers entered the business world in the 1960s, mainly for data storage and calculation purposes. Over the years the role of enterprise information systems has evolved, and the systems are now key of the business and play an important role in all kinds of business decisions, i.e. from a transaction point of view.

For real collaboration with supply chain partners new enterprise information systems are needed. From a technology point of view, two important parts can be identified: (1) the actual integration concept, and (2) an interconnected model of enabling technologies that addresses some of the current gaps i.e. at the operational and tactical level, the Proactive Resolution Broker.

Cost theory explains that the most benefits can be achieved with optimal strategic decisions; an optimal operational decision does not have the same impact. Therefore it is suggested that companies need to focus more on their strategic processes and waste less time with operational issues, although these operational processes are the foundation for strong strategic processes. However, in today's practice, operational decisions consume most of a company's time. Information systems therefore, must ease the operational processes by further automation of the tasks (e.g. exception handling tools), and be a support for human decision-making at the more strategic levels (e.g. good analytical and redesign tools).

Chapter 9 – Enterprise Integration

Software that makes it possible to integrate and to exchange information, with supply chain partners, is key in supply chain collaboration, at least from a technology point of view. That is one of the conclusions of Chapter 8.

This chapter takes a closer look at enterprise integration technology from both a business as a technical point-of-view. Different integration paradigms are identified, and some remarks will be made on how to integrate with business partners. The differences between the older Electronic Data Interchange (EDI) technology, and the newer Extended Markup Language (XML) play a role in most discussion around enterprise integration. Therefore a small section is included in this chapter on this issue. The chapter is included with some remarks about (XML-) standard initiatives, with a special focus on the RosettaNet initiative.

9.1 – Enterprise integration

9.1.1 – Alternative integration models

Generally speaking, there are three alternative models for integration [39], [80]: a *one-to-one*, *one-to-many*, and *many-to-many* model, see Figure 9.1.

One-to-one integrations are by far the most commonly used. EDI integration, direct XML connections, or Enterprise Application Integration (EAI) links from, for example, one Enterprise Resource Planning (ERP) system to another are good illustrations of this model. The main advantages, of this class of integrations, are that they are relatively easy to start up, and they allow for highly tailored arrangements. The disadvantage is that it is very costly to set up and maintain different one-to-one connections with different partners.

Private trading exchanges (PTXs) are the examples of *one-to-many* initiatives. These do not only allow them to connect once with many business partners, but can play an important role to overcome lack of internal system integration, as well. It can be an instrument to show 'one face to the customers and/or suppliers'. Key to the success of PTXs will be the evolution of standardized interconnection technologies from third-party vendors.

Many-to-many integrations can be realized via a hub-and-spoke approach. Herein, a company connects once to a central intermediary – often a specialized industry consortium – that enables connections to multiple other companies. Often, these hub-and-spoke arrangements do include actual or potential business competitors within the same infrastructure. These business-to-business marketplaces can play a role in both data- and process-integration. Whereas data integration approaches translate or standardize product names and transaction formats, process integration approaches also standardize the sequences of transactions and activities that make up a business process. Important advantages of hub-and-spoke initiatives are the lower set-up and maintenance costs. However, although hub-and-spoke approaches have some real advantages, it is not expected that one single hub-and-spoke arrangement will be sufficient for most companies [80].

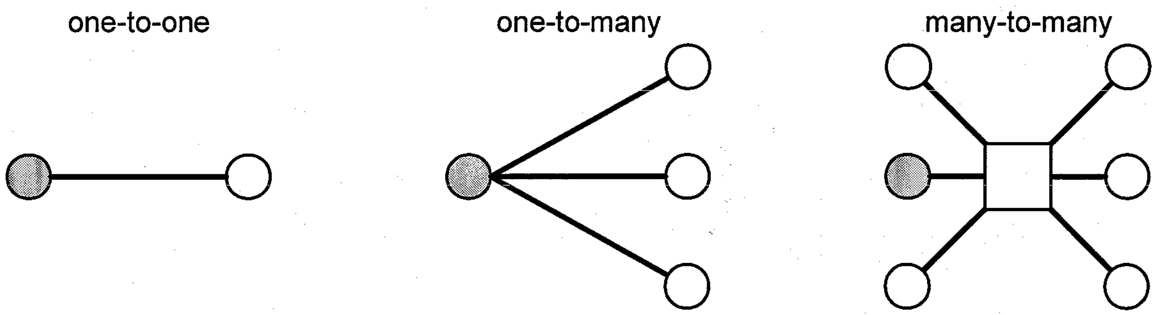


Figure 9.1 – Alternative integration concepts

There has been a shakeout over the last two years in Business-to-Business (B2B) marketplace initiatives – generally of the many-to-many type. The reason that many of these first wave B2B initiatives failed is there solely focus on arm's-length (low) price-driven transactions. Their failure had different reasons: For a buyer, getting supplies at the lowest price possible may not be in its best interest. Other factors, such as quality, timing of deliveries, and customization, are often more important than price in determining the overall value provided by a supplier [121]. However, for buyers, lower prices are not a disadvantage of course, especially for smaller companies the power of aggregated group-buying can be a large advantage [56]. For a supplier, B2B marketplaces and reversed auctions did not bring too many advantages. They gained some increased market coverage, but competition became far stronger [19], what results in lower prices, and therefore direct translates to the margins [81].

The companies that survived, however, have slightly changed their business models, and some of them have gained traction in their specific industry. They do not longer solely focus on buying and selling, but move into the area of managing relationships as well – as PTXs did from the beginning. Today, E2open [u11] is the major marketplace in the Electronics industry.

9.1.2 – The winning concept

Expert opinions differ on what will be the winning concept. Some state [80] that many-to-many approaches, in the end, offer the greatest business value in terms of cost and fit with dynamic business environments. Many others, however, are sure that the one-to-many initiatives have the future [46], [88], especially since it enables the companies to focus just upon those issues they see as important in their trading network.

Industry characteristics such as its structure, history, relationships and dominance are very important issues as well in choosing the proper integration approach. Some Electronics industry examples show that especially the one-to-many model seems to work well (e.g. Cisco's e-Hub, and HP's KeyChain) [88].

9.1.3 – 80-20 rule for integration

Not all relationships with supply network partners (customers and suppliers) are the same. The relationships do differ, and therefore it seems to be logical that the integration model is not equal for each partner as well. The few partners that make up most of the business are, from a financial point of view, the most interesting for deep integration.

The 80-20 rule could be used as a tool to distinguish between level of information integration [80], as is illustrated in Figure 9.2. With the most important partners – likely the ones a company has the most strategic relationships with – a mode of *process sharing* is performed, for example via a private trading exchange infrastructure, a PTX. These partners do receive a special one-to-one treatment, because this strategy gives the companies the greatest control, and integration goes up to the process level. Less important partners can be given a simpler *information exchange*, or, for the least important partners, a simple *self-service information access* feature, through for example an enterprise portal infrastructure.

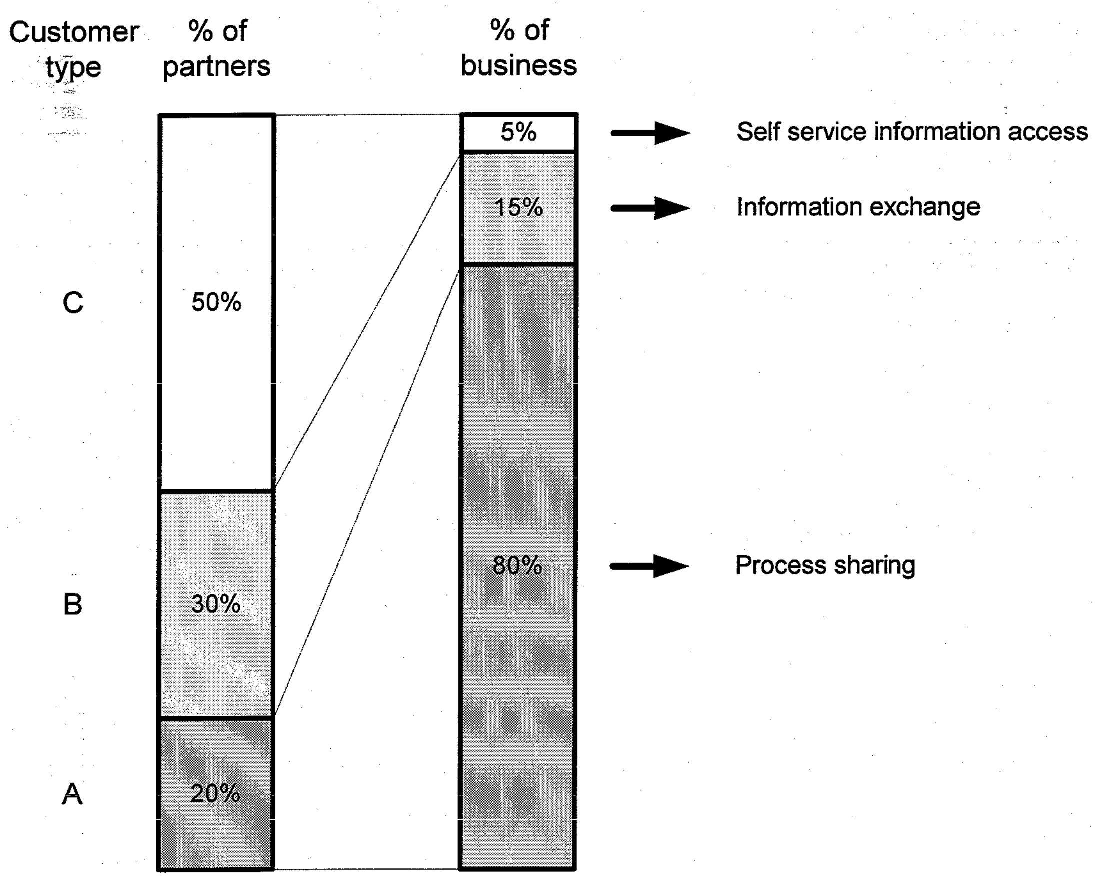


Figure 9.2 – 80-20 rule and Enterprise Integration

9.1.4 – Essential elements

It is common sense that the future of B2B integration seems to be in delivering other services than just transactions, such as collaborative planning, collaborative design, financing, settlement, fulfillment, market intelligence, etc. [19].

Essential elements [94] in these more collaborative business environments are relatively simple ones, such as the ability to create a logical sequence of the execution of the collaborative applications, or functionality to incorporate a rules engine to create decision support agents or conditional branches in the workflow based on actual information. The ability to notify partners of certain events that require a response is essential as well, to effectively integrate and collaborate with them.

The next chapter, therefore, will look at all these elements in more detail, and show that each and all of them are very important. Advanced (multi-enterprise) workflow management, supply chain event management, agent technology, and the use of business intelligence.

9.2 – Integration technology

From an enterprise information integration technology standpoint there are two different types of integration technology: EDI (Electronic Data Interchange), and XML (Extended Markup Language).

The older EDI concept is widely used by large companies, however its drawbacks will prevent significant new investments for the future [52]. EDI transactions are typically sent in batch mode over expensive value-added networks. There is only a limited array of types of information exchange (i.e. transaction processing) as compared to newer broader approaches like the application of XML – the EDI format is fixed, and not flexible. High costs for implementation, low flexibility, and the concept of point-to-point connections are some of its limitations [88].

XML (extended markup language) is seen as the future for B2B interactions, mainly because it seems to be less expensive, and more flexible [88]. There are two important differences between EDI and XML. First, XML has the advantage of shipping universally accepted meta-data – data about the data – with each message. Translation is no longer protocol dependent, as the technology is now the translation protocol. Second, EDI standards are content driven, while XML standards are format driven. For example: The EDI 850 transaction set is the 850, and it may never change. Worse yet, trading partners cannot communicate anything that does not have an equivalent transaction set. However, XML has its own disadvantages [52]. A problem that arises is its different standards, lacking industry-specific definitions, and its flexibility that could in principal turn into a disadvantage. Furthermore, XML can be plagued by the same kinds of maintenance problems that plague EDI [80] – updating multiple XML translators for the same business process.

9.3 – XML based industry standards

9.3.1 – Different initiatives

Over the last years, different XML-based standard initiatives have started. Standardization is needed from a content and a technical point-of-view. The technical structure of the messages needs to specified, as the shared meaning of the terms [25]. If a company specifies prices for example, does that mean prices per unit, per box, or per truckload?

Some standards are cross-industry focused, others more industry-specific. Some standards focus on the Electronics industry in specific. The rest of this section takes a detailed look at the RosettaNet [u30] initiative. Other interesting (more generic) standard initiatives are Oagis [u24] and Microsoft-pushed BizTalk [u4]. It is hard to say which standard will fulfill the specific requirements the best and which one will gain the most traction. However, note that these two aspects do not necessarily go hand-in-hand. What may be stated is that open standards are important, since these make the communication process, company, and software independent.

9.3.1 – RosettaNet - Background

RosettaNet is an industry consortium, consisting of more than 400 of the world's leading companies from all over the Electronics industry, representing more than $1 trillion in revenue [u30], [99]. This self-funded, non-profit organization was founded in June 1998. In August 2002, RosettaNet announced that it will become part of the Uniform Code Council (UCC) [16], the organization best known for developing the Universal Product Code and the bar code system in which it is embedded.

RosettaNet's mission is to drive collaborative development and rapid deployment of Internet-based business standards, creating a common language, and open e-business processes that provide measurable benefits and are vital to the evolution of the global, high-tech Electronics trading network [u30].

9.3.2 – RosettaNet - Standards structure

The RosettaNet Partner Interface Process (PIP) blueprints do differ from most other standard initiatives, since they do not only specify semantic and technical standards, but also the corresponding process standards [9], [11]. This means that RosettaNet also describes the control flow, although the PIP blueprints are not executable and need to be predefined. Nevertheless, RosettaNet delivers a toolset to build collaborative relationships.

RosettaNet's primary focus is on electronic markets with long-lasting pre-specified relationships with known partners. It seems to be less applicable for spot transactions with unknown partners. However, this shall not be a very large problem, looking back at the conclusions presented in section 3.5.

RosettaNet is publishing standards in seven clusters [u30], [80] such as order management, inventory management, and manufacturing. For example, the order management cluster contains the processes of quote and order entry, transportation and distribution, returns and finance, and product configuration. For an overview of the different RosettaNet clusters, see [u30]. The standards include both data definitions and a prescribed process flow.

Currently, not all clusters are filled completely. RosettaNet's philosophy is to standardize a little, use it in production applications (by its members), reflect on the experience and then standardize it some more [99]. See Figure 9.3 for an illustration.

The Order Management cluster is the most popular area for today's RosettaNet implementations [13]. Especially, since this cluster addresses direct transactions between supply chain partners (e.g. procurement).

9.3.3 – RosettaNet - Application

Although current application in the industry is still very limited, companies with large partner communities – such as Intel, Cisco and Nokia – see RosettaNet as a viable and economical framework for their long-term, external, connectivity. These strong players have the power to simply force their trading partners to adapt to their standards, currently RosettaNet. Therefore, these companies are very important for, and driving, RosettaNet development [13].

Industry analysts [13], [99], expect that RosettaNet's full potential will not be realized before 2004. However, RosettaNet compatibility is now already a necessary need for enterprise software vendors focusing on the Electronics industry, since forward looking customers simply require that. Not that strange, since RosettaNet is completely dedicated to the Electronics industry, has a strong member list, and it seems to be that there is no other nonproprietary source of comparable supply chain standards used in production [99]. The recent merge with the UCC is likely to result in a better operability between the retail and the electronics industries [16], furthermore the UCC plays an important role in many other standard initiatives, such as the Auto-ID research program, a sort of super-bar code.

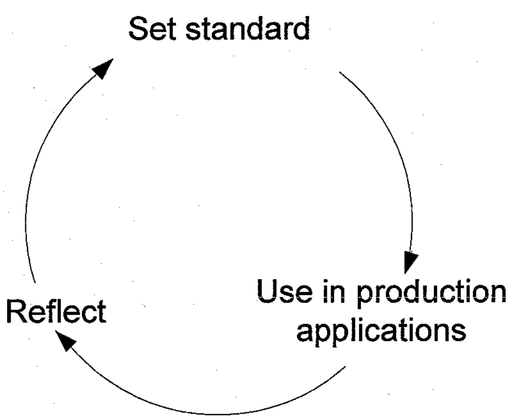
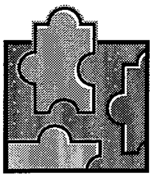


Figure 9.3 – RosettaNet's standardization philosophy



9.4 – Summary

Many collaborative processes are driven by integration and exchange of information between business partners, however there is no single best way of doing this. The integration model, and technology to use, largely depends upon the business relationship, the position and role in the supply chain, the expertise the company has, and the maturity of the technology.

Three alternative models exist: one-to-one, one-to-many and many-to-many integration models. Each of these models has advantages and disadvantages. However, the old 80-20 rule may be helpful in deciding upon the level of integration, and the mode to do so. The most important supply chain partners for example, are candidates for process integration. Less important partners could perhaps better be served with simpler information exchange or self-service lookup.

EDI in the industry practice is still important, since many existing integration structures are EDI-based. Newer initiatives however, are more likely to use XML based messaging. One of the big struggles with XML is standardization. Everybody is free to define the standards, which results in maintenance problems. The new standard initiatives, such as RosettaNet, Oagis, and Biztalk, all started to define a common standard for business transactions. Currently it is uncertain which standard will gain most traction.

Chapter 10 – Proactive Resolution Broker

Chapter 8 suggested an integrated and interconnected model to address and resolve some of today's problems companies face when they want to collaborate with their business partners in their supply chains, i.e. at the operational planning level. This chapter focuses on this model of enabling technologies: the Proactive Resolution Broker.

The Proactive Resolution Broker is a collection of different software components, which are interesting candidates to integration with each other. The different components covered in this chapter are: Workflow Management (WFM) systems, Supply Chain Event Management (SCEM) systems, and Business Intelligence (BI) infrastructures. Enterprise Application Integration (EAI), which is part of the model as well, is already covered in Chapter 9, and therefore not discussed here.

10.1 – Integrated model: the Proactive Resolution Broker

As the business drivers and technology issues introduced in Chapters 8 and 9 show, it is worthwhile to combine enterprise integration technology, with advanced (multi-enterprise) workflow management (WFM) technology, supply chain event management (SCEM), and the use of business intelligence (BI). Some experts [116], [125] already suggested to combine Enterprise Application Integration (EAI), with workflow management technology. However, so far, a coupling with SCEM and BI seems to be overseen. Figure 10.1 shows the framework suggested here, which combines all these technologies. This vision will be referred to as the Proactive Resolution Broker. Note that WFM and SCEM are separated here. Some see SCEM as a part of WFM; however, here both acronyms have been separated to show their importance.

This model does especially address the needs for optimization technology at the operational and tactical level; see Figure 10.2 for an illustration. The model is highly simplified, it lacks the links to other applications, and it does not address the exact manner how these four elements are precisely integrated. That is subject for further research, and goes beyond the scope of this project. The remainder of this Chapter details all the different parts one-by-one, except EAI, which is already largely covered in Chapter 9

Note that some refer to Agent technology as essential for applications as suggested here. It has been left out here, since its application in practice is still unclear and uncertain; this in contrary with the other technologies which are available as of today. Some notes on agent technology can be found in Chapter 15.

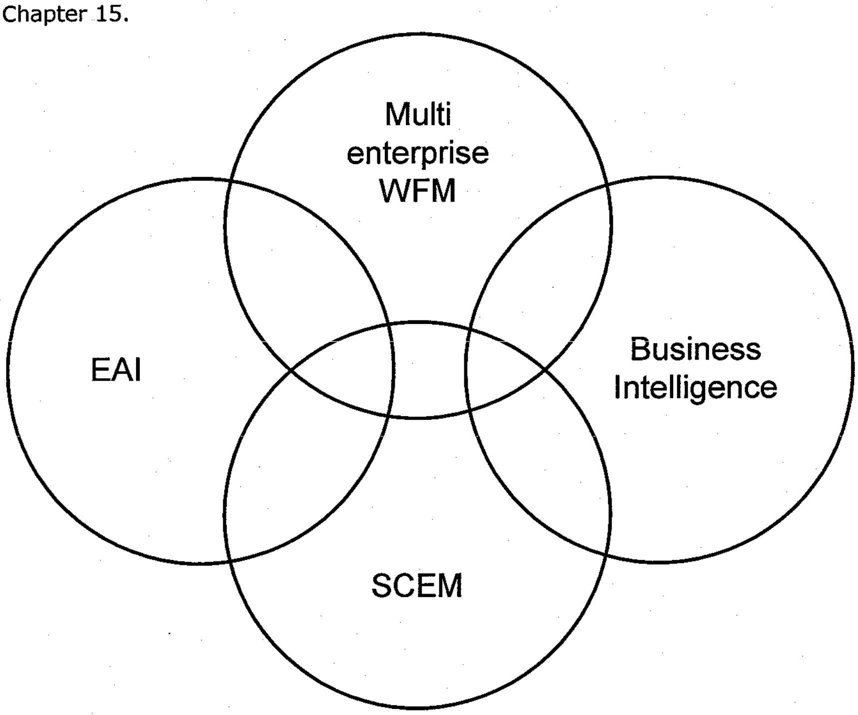


Figure 10.1 – The Proactive Resolution Broker concept

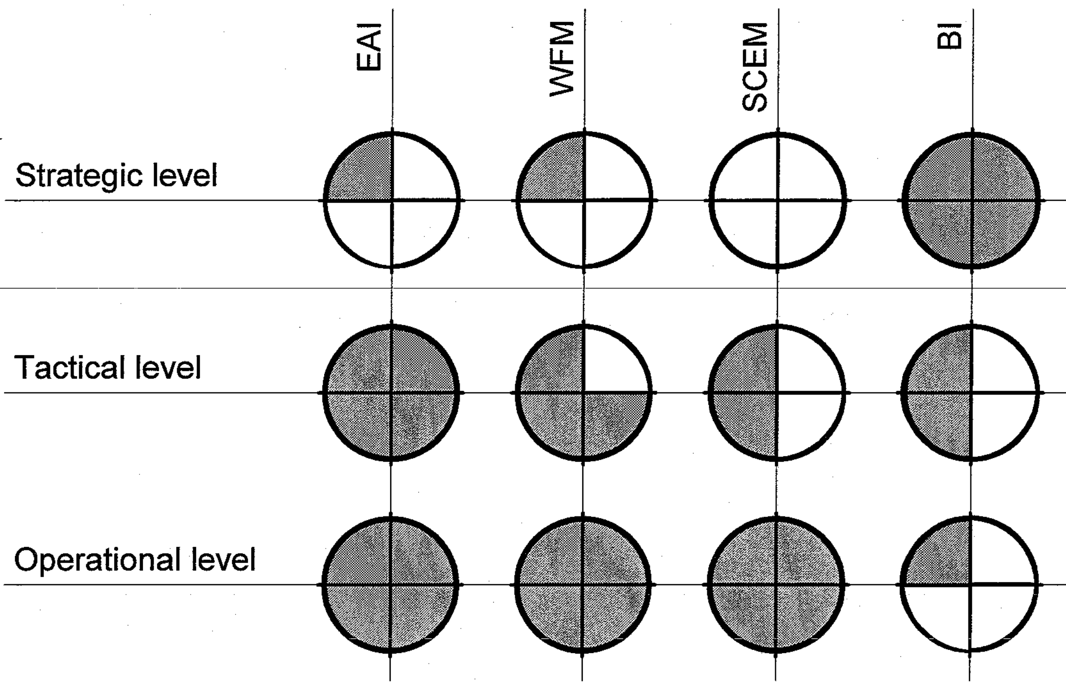
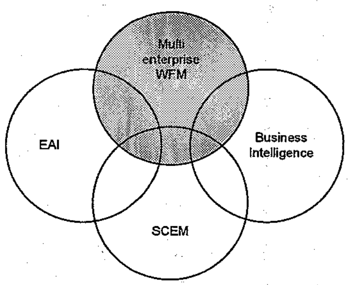


Figure 10.2 – The Proactive Resolution Broker concept at different planning levels (the darker the point, the larger the influence)

10.2 – Workflow management systems



10.2.1 - Background

Workflow functionality is very important in the new era where collaboration with supply chain partners becomes more important each day. Workflow functionality could be applied in two different ways: as a tool to support collaborative relationships, or more extreme, as the tool to collaborate.

10.2.2 – Workflow to support collaborative relations

The ability to create a logical sequence in the execution of a collaborative software solution is essential for receiving the greatest value from such a solution [94]. Many collaborative processes, like for example most processes as described by RosettaNet (see Section 9.3), require supply network partners to follow certain steps and than respond to an event. Like for instance: sending a notification that a purchase order is accepted or rejected (the RosettaNet PIP 3A4). Workflow technology is an essential element in this field.

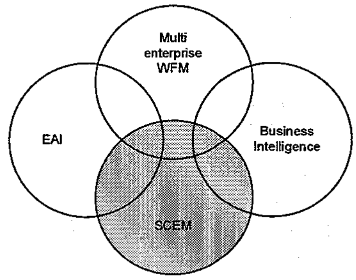
Event management, and exception handling, do also have a strong relationship with workflow tools. Rules engines monitor for exceptions and special events, and execute appropriate workflows based upon actual information [94]. Part of such solutions could be the use of intelligent agents, see also Chapter 15.

10.2.3 – Workflow as the tool for collaboration

Current workflow applications generally focus on intra-organizational workflows, and can be linked with different enterprise information systems. However, in the connected world (such as described in this report) a new generation of workflow technology is needed [9]. A very flexible workflow technology, that can cross organizational borders, and can be changed on the fly. It cannot just coordinate the flow of work in an organization, but also between different organizations. The technology needs to be flexible, because the organizations involved are essentially autonomous and have the freedom to create or modify workflows at any point in time.

Cross-organizational workflows are more susceptible to errors than intra-organizational workflows, and these errors are also more difficult to repair, since more partners are involved. Support of one-of-a-kind processes (such as spot buying at an unknown supplier) is even more complex. Eindhoven University of Technology professor Wil van der Aalst, is working on a new workflow modeling language, known as XRL (eXchangeable Routing Language), see for example [9]. XRL could be a major step forward and may have many interesting application areas.

10.3 – Event management



Exception-based management seems the way to support collaborative processes [12]. The normal flow of information between (and within) companies gets handled through regular automation rules, and in case an exception occurs users (along the supply chain) get alerted. This way minimizing the amount of information that needs to be reviewed, and therewith the time that operators need to spend looking for problems. Furthermore this might help to ensure that naturally occurring human errors and equipment failures are minimized [93], and thereby significantly improving the overall reliability of the total supply chain. Software that helps to do this is generally referred to as supply chain event management (SCEM) software.

Event management software, in general, performs several tasks [64]; it *monitors* events (for example: the current status of inventory, orders, shipments, production, and supply), and *notifies* decision makers if an action needs to be taken or a trend is discovered. Furthermore it has *simulation* features (to assess what will happen if specific actions occur, or to recommend certain actions), has the ability to *control* the process (by giving the decision maker the tools to react upon the notification), and often all this is combined with intensive use of *measurement*, such as Key Performance Indicators (KPIs) and metrics. The whole process is visualized in Figure 10.3. Alerts can be either passive (alert only), active (alert with suggested course of response/actions), or auto-responsive (a fully automated response triggered by an event/alert) [24].

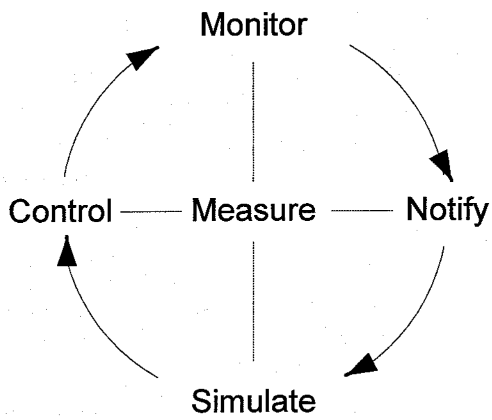


Figure 10.3 – Event management elements

One of the objectives of event management software is to ask attention just for those events that need attention, while hiding all other situations. It filters the needles from the haystack. Partially automating how exceptions are addressed, and effectively presenting critical information turn out to be critical elements in further optimizing the enterprise and preparing it for collaboration [64].

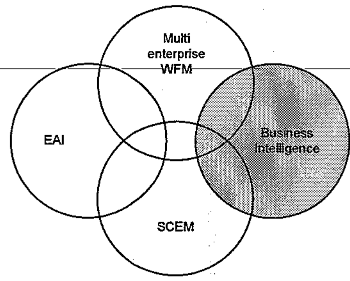
Event management software can tackle two issues [64]: it can be used as a toolset to *react* upon events, or a tool to *discover* trends, where it comes close to the business intelligence field. The software can be used to highlight events that require special, and perhaps immediate, attention or prioritization, while building on the skills and knowledge of the users. On the other hand, this kind of software functionality can be used as well for supply chain performance management tasks providing the ability to review exceptions, identify trends among the exceptions, and bring them to the attention of those involved in the process. By recognizing the trends and not just individual exceptions, event management software assists with collaboration.

Workflow functionality is an important element within exception management. Today, follow ups (on events) are needed within a certain timeframe. The systems needs to decide if an exception will be handled via a human operator, or if it is handled completely automatically through the system. In case the need exists to handle the exception via an operator, the system still needs to come up with an optimal suggested solution, not only to guide the human in the handling process, but also as a preparation in case the human intervention does not occur. If the operator cannot respond to the event within the specified timeframe, it can be decided that it may be best to continue the process by responding automatically, without the human intervention what would have been preferable.

Exception situations can occur on all different kinds of data, such as differences in price, fulfillment times, alternative items, and contract aspects. Change situations are important to monitor.

Note that exception handling is likely to result in extra (rush-) orders – see Example 6.2 for an illustration – therefore it does not lead to very stable situations. For a supply chain partner, a stable situation (where demand is known far in advance) would be preferable. A customer who is going to miss due to a changed situation wants to fulfill its orders by entering a rush order, which could lead to rush orders for the supplier also, thereby introducing more uncertainty and unpredictability in the total supply chain. Therefore, it may be concluded that exception handling could be very useful, however, it should be implemented with great care.

10.4 – Business intelligence and historical data



10.4.1 – The use

Business intelligence and the smart use of historical data can be performed in two different manners and for different purposes. First, it can be used for *monitoring and reporting* purposes, mainly for decision taking at the strategic level. Secondly, it could function as the *basis for some real-time decision taking,* which is especially interesting at the operational and tactical level, as an example will show. Where the first usage-type is widely accepted in practice, the latter has been largely overlooked until now, although especially there seems to be real, but currently unleashed, power. Data analytics could lead to recommendations regarding the best course of action to take when an event occurs [24].

10.4.2 – Monitoring and reporting

Companies can use business intelligence to monitor business performance. Business intelligence tools help to collect data (mostly in a data-warehouse), to analyze the data and to compare that to defined performance metrics – so called KPI's (Key Performance Indicators) – this helps to determine how to proceed and even if to proceed. These measurements [96] helps to identify if costs are being reduced, but do not in themselves result in savings, they point to specific initiatives that are successful or need tuning. Performance measurement indicators allow management to quickly review key metrics, and act upon. The data is mainly aggregated in management reports, and being used to take investment decisions. Here, BI and historical data is mainly used for optimization decisions at the strategic planning level (see Figure 10.2).

Next to monitoring a company's own business, collaborative monitoring, and sharing, of performance information [12], [96] of the entire supply chain, against the defined supply chain objectives, can make it possible to control and optimize the operations of this supply chain.

10.4.3 – Basis for real-time decision taking

Many parameters, as currently used in enterprise information systems (i.e. ERP (Enterprise Resource Planning)), have a static nature, and are not likely to change frequently. In implementation practice, many of these parameters have been set during implementation time, and have never been checked or updated later anymore (see Example 10.1). Quite a paradox, since many enterprise software improvement initiatives performed over the last decades have tried to optimize the architecture and characteristics of these software systems – with different, but generally, positive results. However, this problem has largely remained untouched.

Generally speaking, there are two ways to solve this problem. The first approach would be to make the process-owner responsible for updating the system. This process-owner could be an employee of the company itself, or an employee from a supply network partner (supplier, customer, third party logistics (3PL), etc.). The second problem solving approach could be to make smart use of historical data. At the operational level, reference information [106] such as delivery performance and reliability, and all kind of chosen preferences can be used as input for automated decision taking. For example (see also Example 10.1): Instead of using a static expected distribution time (as once entered when implementing the software system), it might be more valuable to compare this with realized deliveries from the past, in a certain timeframe, and to apply some mathematical rules to help find the optimal distribution time to use for the calculations.

It may be expected that the second approach would probably work best, since that can be largely an automated process. However, a combination of the two suggested approaches might be interesting as well, where the process combines the data from the different sources and applies its advanced rules in the decision taking process.

Example 10.1 – Static parameter problem

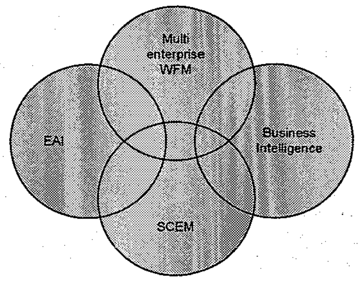
Implementation of Enterprise Information Systems can be a tough job. At implementation time, the implementation consultants set all different parameters and customize the standard software to the company's needs.

In this example the (during ERP implementation – 5 years ago) expected delivery (or lead-) time from supplier ABC to warehouse XYZ is 4.0 days. However, over the years supplier ABC has proven to be faster and very reliable in its deliveries to warehouse XYZ. The last 5 deliveries took: 1.9; 2.2; 2.0; 1.9; and 2.0 days.

Therefore a new order would probably take again a little bit more or less than **2.0 days**, in stead of the **4.0 days** the ERP systems uses in its calculations. This is a large difference, which probably results in excess inventory, non-optimal batch sizes, extra uncertainty in the system, etcetera.

Note that other sources – such as [122] – do recognize the limitations of parameters in modern enterprise information systems as well.

10.5 – The solution



The Proactive Resolution Broker model addresses most of the business issues listed in section 8.3. This way, enterprise information systems become real-time or even pro-active instead of the re-active nature they currently have. Event notifications trigger resolution processes, where intelligent workflow systems guide users through the decision process towards the best possible resolution. The visibility within one's own organization grows, as it is likely to increase between supply chain partners. Multiple enterprise workflow systems, are even capable to address process sharing between network partners. Business intelligence plays an important role. This way the system is capable to base decisions on the past, and even to learn from previous events and decisions taken there.

Therefore rethinking and connecting the concepts of EAI, WFM, SCEM and BI, and delivering this as a software solution seems to be very interesting. Interesting, at least for the needs as known from the Electronics industry, but perhaps for other industries as well. However, in practice it will not be as easy as just described here in a few pages. Nevertheless it could be worth the try.

Note that a recent (August 2002) Aberdeen Group report on *event management* [24] came to a conclusion, which shows a large similarity with the model as suggested here. The report discusses the future of SCEM solutions, and recognizes the need to combine SCEM with business intelligence (and the use of historical data), and strong process technology. They also state that it is not a stand-alone application; it is an enabling technology, dependent on a networked environment to be useful. The components they describe as required are: integration, process management, portal integration, visibility, event management response, and analytics.

10.6 – Enterprise software vendors

Many large enterprise software vendors are active in the different functional domains as are discussed in this model. These vendors are either (large) ERP vendors, or best of breed (BOB) vendors specializing in one (or more) domain(s).

The EAI domain for example is served by BOB vendors such as Tibco [u35] and IBM (MQ Series) [u18]. Cosa [u8], Staffware [u34], and IBM (MQ Series Workflow) [u18] are some of the players around in the WFM domain. The SCEM domain is served with BOB software from Sockeye Solutions [u33], Eventra [u14], i2 Technologies [u17], and many others (see [24]). Cognos [u6], Business Objects [u5], and Crystal Decisions [u9], are some of the important names in the BI market.

Although BOB vendors offer best-in-class functionality in their area of expertise, it could be hard for them to combine functionalities as proposed in the Proactive Resolution Broker model, since application functionalities from different domains need to be combined. It may be easier for ERP vendors, which generally offer their own functionalities in these different domains as well, to integrate everything. Furthermore they can integrate it with other enterprise applications as well. Important Baan [u3] competitors are SAP [u31], Oracle [u27], PeopleSoft [u28], JD Edwards [u20], and Navision [u22]. ERP vendors can also consider partnering with BOB vendors, to gain domain specific knowledge and best-in-class functionality.

10.7 – Summary

The Proactive Resolution Broker is suggested as a model to solve some of the most common business issues companies face when they move forward and prepare their enterprise information systems infrastructure for collaboration with business partners.

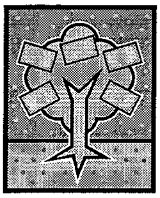
A proactive, intelligent resolution system can be created by combining four components: Enterprise Application Integration, Workflow Management systems, Supply Chain Event Management systems, and Business Intelligence.

As of today, each of these components has their own application area, but in combination they could be even more powerful. Especially the decision taking at the operational and tactical planning levels could be well served with such a solution.

A pro-active monitoring of events could result in an alert message to a user, which will be guided through a resolution process, in where the system handles historical data and gives the user the tools for optimal decision making.

Note that although the concept seems to be simple, the actual realization of a Proactive Resolution Broker could be relative complex. Nevertheless it is an area interesting for more research and pilot-development.

Part IV – Close look @ Procurement



Part IV – Close look @ Procurement

The procurement domain is focal point in this part of the report. Procurement, functions as the domain where all previously collected theory and generated concepts are applied; resulting in some specific software recommendations (for Baan) in the last chapters.

Chapter 11 – Procurement

This chapter is all about procurement. To begin with, it explains why the choice has been made to focus on exactly this domain. A good definition and a detail description of the process are addressed in the next sections. The later parts of this chapter focus on software for procurement and on collaborative procurement.

11.1 – The reasons to focus on Procurement

The procurement domain is focal point of the entire Part IV. In this part, all theory, ideas and concepts collected so far are combined and applied in the procurement domain. The choice to focus on the procurement domain has been made after deliberation – in April 2002 – with the Baan, Deloitte and Eindhoven University of Technology coaches. However, it has been a logical choice, since procurement is a promising and necessary domain for the companies that are focal point of this research (see Chapter 4). Furthermore, collaborative procurement turned out to be an interesting aspect of some of the defined collaborative solution areas (see Chapter 5 and 7).

The basic role of an Electronics Manufacturing Services (EMS) provider is legitimized by the structurally lower (manufacturing) costs than the Original Equipment Manufacturer (OEM) it works for; mainly derived through shared economies of scale and special skills (see also Part I of this report). About eighty percent – numbers vary between 70% and 90% [65], [106], [108] – of their costs of goods sold comes from materials sourced from suppliers.

To solidify its own position, EMS's must try to take over the procurement role from the OEMs (as shown in Chapter 4), and control the procurement activities. It is in their best interest to promote collaboration between the supply chain partners (i.e. part suppliers, the OEM, and the EMS itself) to minimize the costs of the key components, see for example [65].

Cost savings at the supply side of the business go directly to the bottom line. Because of this, a dollar saved on the procurement side is the equivalent of increasing revenue by perhaps five or six times that. For example, a 4 percent cost savings achieved by a procurement application has the same effect upon the bottom line as an increase in sales of 20 to 24 percent [56]. This phenomenon is explained by the concept of the purchasing profit multipliers; see [106] for more information. It shall be clear that EMS companies – that have only very small profit margins, as Appendix 4 shows – can improve their business enormously by a more stringent focusing on procurement optimization.

Not surprisingly, software to automate procurement does exist since the early days of automation. In the beginning as basic tools to support the purchasing staff, later it helped to automate transactions and interactions with suppliers. The purchasing module of Enterprise Resource Planning (ERP) systems is the module that is the most frequently implemented in manufacturing companies [101]. Now, it is about to move beyond that and play an important role in more collaborative relationships with network partners (i.e. suppliers). Since recently, software support for supplier facing processes in a company, mainly procurement related processes, – processes such as the management of supplier contacts, procurement processes, sourcing initiatives, and collaborative design – are referred to as Supplier Relationship Management (SRM) [18], [104]. Maybe a new hype word, but it is absolutely a promising area, where large savings can be achieved.

11.2 – Definitions of procurement

Confusion consist around the meanings of different terms that do relate to the supply-side of organizations, such as for example the meaning of sourcing, purchasing, procurement, buying, and supply. This report takes the definition as used within the Baan organization as the standard, but be aware that different authors and organizations (like for example [8], [119], and [u32]) may use another interpretation of the same terms.

The structure as shown in Figure 11.1 is the structure as used in this report. Herein does *supply* have the broadest scope of activities. It captures the whole collection of processes to procure, receive and handle goods and services to meet planned or actual demand. Supply does consist out of procurement and logistics.

Procurement is the actual acquisition process of raw materials, components, Maintenance, Repair and Operating (MRO) goods, services and capital goods, from outside the corporate organization, required to manufacture saleable goods/services directly and indirectly [37], [85], [115]. *Logistics* relates to issues such as the reception of goods, warehousing, management of transportation, etcetera.

Purchasing is the transactional aspect of procurement: the real acquisition of goods and services. Ordering goods is an example. The other aspect of procurement is sourcing, which lays the foundation for regular day-to-day purchase operations. It involves the identification, evaluation, negotiation, configuration, and monitoring of products, services, and suppliers for both indirect and direct materials. *Sourcing* is more situated at the strategic level in the organization. Putting it short, it can be stated that the strategic aspects of procurement are managed by sourcing, and the operational aspects are the transactional, day-to-day operations associated with purchasing (sometimes referred to as buying).

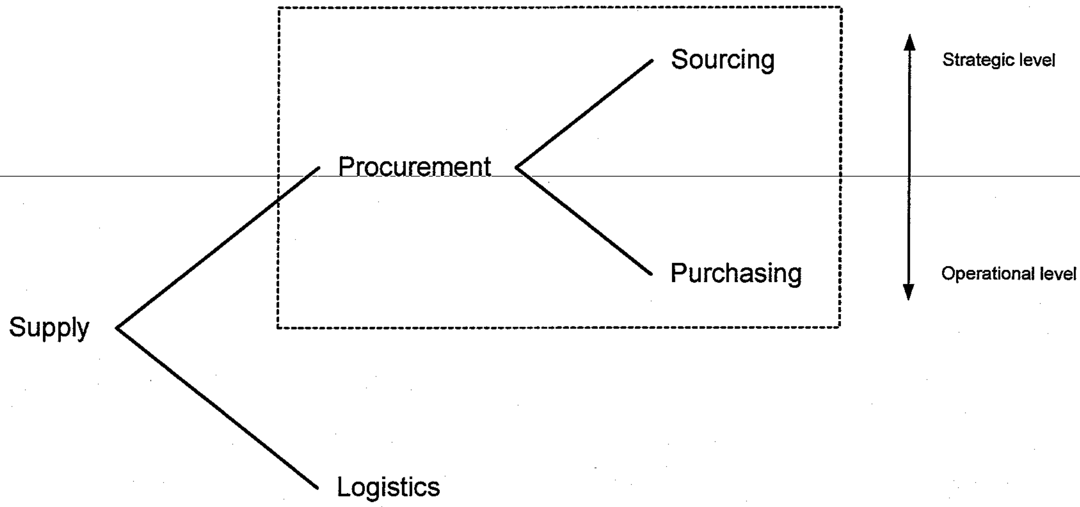


Figure 11.1 – Procurement definitions

11.3 – The process in detail

11.3.1 – Different steps

The procurement function can be divided into different steps. A simple division is shown in Figure 11.2, which is adopted from [106], [119]; but slightly adjusted. More complicated divisions and figures can be found in for example [20] and [45], but in essence they do all cover the same. The figure is very basic, and does not need much explanation. The white areas are generally part of *sourcing*, and the gray parts are *purchasing* related. Note that issues such as overdue lists and lists of non-accepted receipts are part of the *fulfillment + settlement* step, and that the *evaluate* step includes activities like vendor-rating and vendor-ranking.

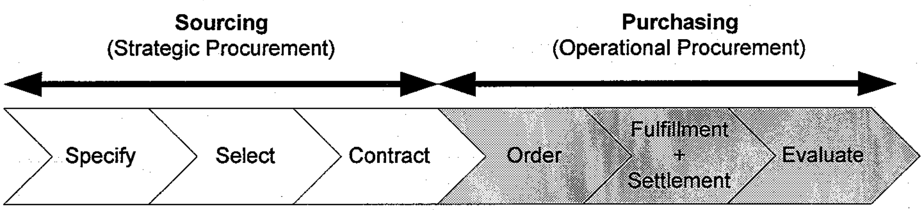


Figure 11.2 – Procurement steps

There are different sources that can trigger the procurement function, see Figure 11.3 (source: [106]), but most frequently it is triggered by the notice of a need, of a customer, that possibly should be satisfied by goods and / or services supplied by external sources [106].

In slightly other words, these concepts return in Figure 11.4 (source: [106]), which shows four different procurement practices. It extends upon the simplified process as showed in Figure 11.2. Situation one can be characterized as *'provision from stock'*, where not much coordination is needed. The second situation is a *purchase order* or *call-off*. In case number three, a *supplier selection process* is first needed, and than *contracts* need to be defined. This takes more time than option one or two. Situation four, finally, is a situation in which a specific requisition leads to the *search* for suitable suppliers, their qualification, selection and contracting. Before the required items or services can be ordered.

11.3.2 – Procurement categories

The figure imposes that in most cases, goods can only be ordered from a specified contract, which is contracted with a qualified supplier. However, that is not entirely true. It largely depends upon the purchasing category a good belongs to. The concept as introduced by Kraljic in 1983 [70], [106], [117], is useful material to differentiate between different categories.

The Kraljic purchasing matrix recognizes four procurement categories, by distinguishing between strategically vital goods and those that are in ample supply or easy to substitute, and between critical and non-critical suppliers: *strategic* (high profit impact, high supply risk), *bottleneck* (low profit impact, high supply risk), *leverage* (high profit impact, low supply risk), and *noncritical* (low profit impact, low supply risk). Note that this division is not complete synchronous with the division in direct and indirect materials as often made by others; although herein direct materials are mostly strategic items according to Kraljic.

Companies can reduce prices of goods they buy, depending on the category these goods are part of [65]: in case of essential goods that might hitherto have come from a single supplier, buyers can cultivate a second source in order to introduce a degree of price competition. In the case of less essential goods, companies can play-off suppliers against each other; real spot-market buying, where the price is an essential element. Note that [40] gives an interesting overview of all hidden costs that relate to the procurement domain, which can give feed for improvement initiatives.

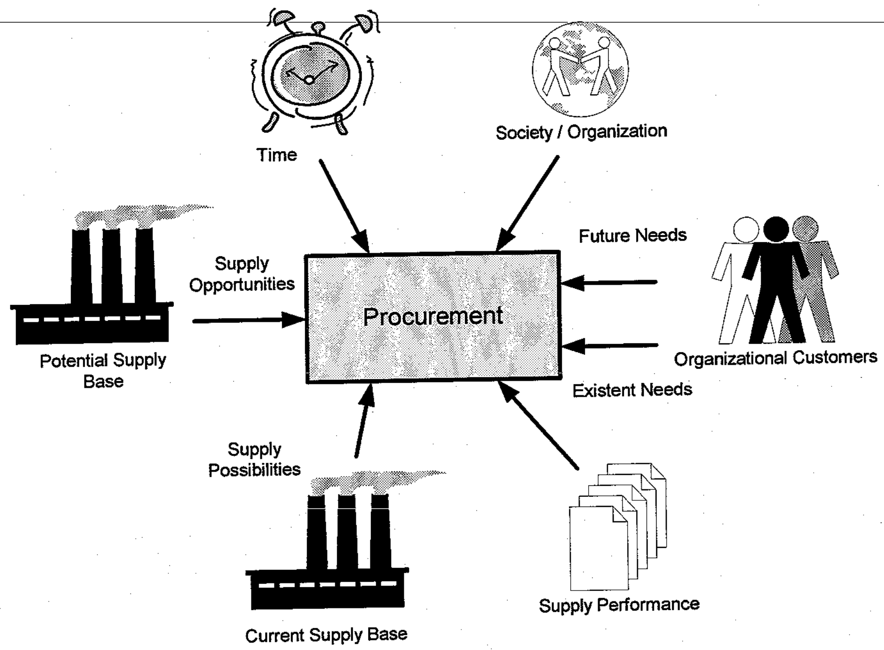


Figure 11.3 – Events triggering the procurement process

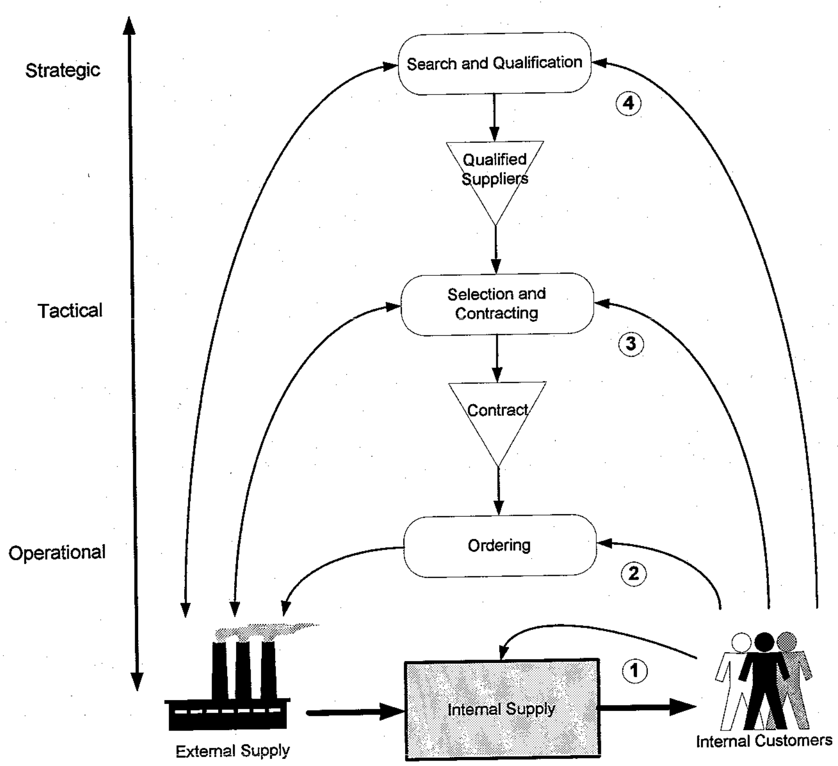


Figure 11.4 – Different procurement practices

11.3.3 – Collaboration in procurement

Over the last years, long-term collaborative approaches based on trust and partnerships or alliances turn out to be very beneficial [38]. A paradoxical situation, since the best defense of a buyer's position is the maintenance of perfectly competitive supply markets, with low barriers to entry, low switching costs, and limited information asymmetries, which pleads for non-collaborative relationships with competition at its basis.

It is clear that the Kraljic procurement categories have their influence on collaboration initiatives [74]. Collaboration in the strategic domain can deliver real benefits, where collaboration in less strategic domains can only have a negative influence, when performed badly, the items are so common that much other than price does not count. In stead, it seems to make more sense to automate the procurement of commodities than to collaborate with partners in the less strategic areas.

A simple form of collaboration in the procurement area already exists for years, especially between strategic partners in the direct material domain. They share schedules together, and therefore do not only exchange actual purchase orders, but work with an order planning horizon which includes several different types of orders as well, i.e. so-called *firm planned orders* (orders that are likely to be released) and longer-term *forecasts* (suitable for long-term planning purposes, but no orders), see Figure 11.5. The ordering of indirect material (less strategic items in Kraljic terms) is mostly event driven.

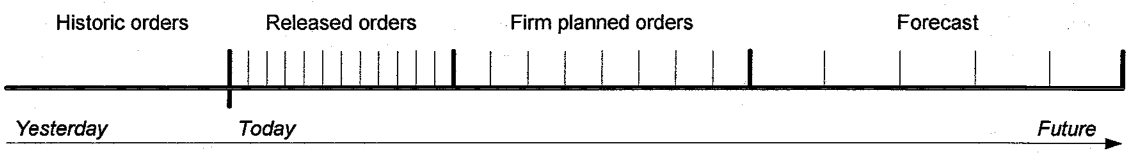


Figure 11.5 – Order planning horizons

As shown, procurement is closely linked with forecasting. Next to that, it could be interesting as well to integrate the procurement domain with the design processes [106]. Here, however, that is no subject of focus.

11.4 – Procurement software

11.4.1 – Introduction

In the past three years (1999-2002) procurement software (i.e. Internet-enabled software) saw both the best and worst of times [1]. Hype became over-hyped, and suddenly everything went down; true for the whole Internet market, and also the case for procurement software. Many early e-Procurement initiatives failed, due to the single focus on low price-driven transactions [121], and no support for direct materials ordering [44].

The growth rate predictions for procurement software from some years ago, have been downgraded by the analysts and experts, due to this .burst-situation [44]. The same experts however, still think that there are some real opportunities to (further) automate the procurement process, which is inline with everything as described, earlier in this Chapter. To get an insight for today's adoption rates for e-Procurement related solutions see [51].

Procurement software has to support the procurement process, a process that consists of different (sometimes independent, but inter-related) steps. Most software solutions only address some of these steps, which results in a portfolio of software solutions serving the total procurement market.

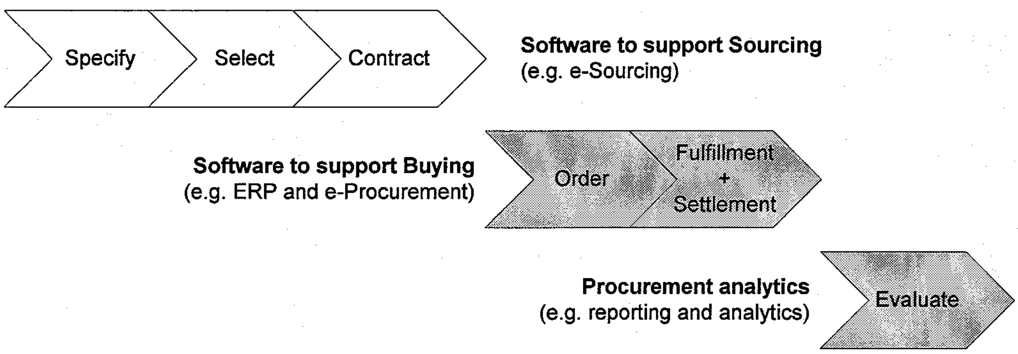


Figure 11.6 – Procurement steps and software solutions

There is not much clarity around a good division for these procurement software solutions, as can be noticed by comparing [1], [22], [43], [62], [92] and [121]. Here all basic ideas are combined, and integrated with the procurement model introduced in Figure 11.2. Figure 11.6 shows the division to use in this report. Three different procurement-software categories are identified: software to support *sourcing*, software to support *buying* (and receiving) processes, and *analytical* software.

11.4.2 – Software to support Sourcing

Software focused to help in the strategic sourcing processes, does generally cover all issues related to identifying new suppliers, as well as sending, receiving and analyzing RFQs (request for quotations). These applications handle a small number of transactions, but these transactions are of high-value. The suppliers are likely to participate, while they directly see the benefits of participating. They are aware, that if they do not respond to a buyer's sourcing event, the will lose business [22], [43], [105]. e-Sourcing tools can be a useful instrument to lower the *noncoordination costs* [1] (see also Section 2.6), since the tools are moving beyond price-focussed bidding events towards systematic tools that model total landed (supply chain) costs [86].

Most sourcing events are initiated through requirements such as: new product development initiatives, engineering change notices, contract renewals, and price revisions. Sometimes events are due to a necessity to temporarily source the material due to unexpected disruptions of the supply flow, such as man-made events or natural disasters. See also Figure 11.3. Traditionally a zooming approach [106] is suggested in the sourcing process, where a long-list is refined into a short-list, which actually leads to a signed contract.

Enterprises utilizing Internet-based sourcing technologies have been able to negotiate significant unit cost (i.e. price) reductions, reduced sourcing cycles, and improved service levels. Furthermore they have enhanced decision-making capabilities, and gather improved product, market, and supplier intelligence [85], [105].

e-Sourcing includes functionalities like category management, cost savings tracking, specification management, and supplier performance management, cost estimation and target costing, knowledge management, market analysis, make versus buy analysis, value engineering, buyer-supplier joint cost reduction programs, and more. Mainly intelligent software support for human decision makers – exactly as is suggested in Section 8.4.

Note that some (software) companies active in the e-Sourcing domain, such as FreeMarkets [u16] and ICG Commerce [u19], follow a slightly different approach. These companies are primarily service companies; they have industry experts who find suppliers and organize reverse auctions to satisfy their clients' procurement needs. Both companies also have separate software products for companies that wish to conduct their own auctions.

11.4.3 – Software to support Buying

There is a large difference between the buying behavior of direct and indirect items, or between items classified in another segment in the Kraljic matrix, see Section 11.3.2. Critical items for the production process, get generally planned and ordered through enterprise software, since the items or materials are needed in the production. This was traditionally, and still is, an important aspect of ERP packages.

Software can support these direct purchase orders, and it can also supports more schedule based ordering (which are a result of the planning) [45]. Purchase schedules help to build trust, since repetitive purchases are assured. It also justifies investments in integration methods with supply chain partners. Ad hoc purchases for direct materials are undesirable, since they are the result of poor planning or uncontrollable external events.

Software targeting direct procurement activities has resulted in improved visibility of customer demand and supply chain capacity, increased accuracy of production plans and forecasts, reduced inventory and operations costs, shortened procurement cycles, and enhanced responsiveness [85].

Buying indirect material was traditionally an off-line process. The Internet hype was the starting point to automate i.e. MRO (Maintenance, Repair and Operating goods) purchasing, since these goods were well suited to automate, because they are relatively easy to specify, and most purchases are made from a simple catalog with fixed prices [56], [92]. Note that most MRO goods are bought from type C suppliers [44]; compare that with the ideas as introduced in section 9.1.3, which pleads for a very simple interface with these suppliers.

Software that targets indirect material purchasing – in practice, a synonym for *e-Procurement* [45] – has resulted in reduced prices paid for indirect goods and services, improved contract compliance, shortened procurement and fulfillment cycles, reduced administration costs, and enhanced inventory management [85]. Often this kind of software includes spend management software: to control the risk of losing track of who is spending what [51].

It should be stated that the buying processes (for either direct as indirect items) can be very well automated. Advise is to automate the day-to-day ordering process (see also Section 8.4), and to introduce a platform as is suggested in Chapter 10 to provide support in the situations where exceptions occur and corrective actions are needed. Speaking in cost terms, as covered in Section 2.6, this kind of tools do mainly influence (and lower) the transaction overhead costs [1].

11.4.4. – Procurement Analytics

Although linked to the last two steps in the procurement process (control and evaluate), analytics is an important element for almost the entire procurement process. It helps to address questions that center around the effectiveness (e.g. which price, which deliver reliability, which quality, which service) and efficiency (e.g. costs for organization, information systems, procedures, procurement staff) of the procurement processes [119].

At the *strategic* level – where analytics meet the sourcing steps – analytics could be used for [20]: identification of sources, spend analysis, supplier evaluation, contract management, and prioritization of sources. At the *tactical* level analytics could be used for measuring the process performance, order analysis, catalog analysis, contract analysis and bid invitation and bidding. At the operational ordering/buying level it could be useful (in combination with a monitoring and exception platform) to perform exception expediting, routine status checks and advanced status checks.

The CAPS Research center identifies the following Key Performance Indicators (KPI's) [119], which are relevant for application in the procurement domain:

- Procurement as percentage of goods sold
- Operational procurement costs compared to total procurement costs (%)
- Procurement spends per staff member
- Number of active suppliers per staff member
- Procurement revenues per active supplier
- Operational procurement costs per active supplier
- Number of electronic (procurement) transactions
- Number of article codenumbers per staff member
- Cycletime of the inventories
- Percentages procurement cost reductions

These KPI's can function as a tool for industry benchmarking. Important is to do not only compare on one single aspect, but on a combination of KPI's.

11.4.5 – Integrated solutions

As almost all enterprise software, it is important that the separate solutions integrated with one another, which is currently not always the case [37]. Integration between different procurement applications, and integration with applications in the other domains. Design decisions for example, can better be made with insight into information about component costs, spend analysis for components available from existing suppliers, and supplier availability, performance and quality [104]. Another example are planning decisions that may be very well coupled with information on supplier capabilities [45]. Part II of this report provides more information on different kinds of integrated collaborative solutions.

Since marketplace technology was closely linked with some of the most visible e-Procurement initiatives from the last years, it might be good to make some remarks here: Chapter 9 already showed that the choice between private trading exchanges (PTXs) and public marketplaces largely depends upon the trading company. Today, analysts and consultants [88] seem to favor, and recommend, especially the PTX initiatives for larger companies. August 2002 AMR Research figures (from a cross-industry (not Electronics specific) research), show process cost savings on average of 23%, and purchase material cost savings of about 13%. See [17] for more details. A large advantage private trading exchanges offer, is that the company can configure it exactly to its, and its business partners', needs. The PTX (sometimes referred to as supplier trading exchange) handles all the processes that face the supplier side of the business, and give the suppliers advantages in an ease of connecting and a central contact point, as well as it can be the place for extra features such as supplier performance data, etc.

11.4.6 – Cost aspects

Procurement software reduces search and communication costs dramatically, and therefore make it worthwhile to consider drastically different frequencies and choice-sets in the different procurement processes, e.g. supplier selection, reconsidering the current supplier base, and sourcing [22].

There are two different types of cost reduction that can be realized via procurement applications: *transaction overhead costs* and *noncoordination costs* reductions. Noncoordination costs are lower through lower procurement costs. Transaction overhead costs are reduced through standardization of the procurement process, lower inventories, product/process enhancements, and lower quality costs [20].

Different operational aspects may lead to reductions in costs, such as: reduced transaction times, reduced transaction costs, no maverick buying, standardization (of processes, content, etc.) and simpler purchase processes [20].

Another aspect is the reduced number of suppliers [92] – specifically in the area of indirect materials – something caused by different reasons such as the use of contracts, catalog management (which goes better with fewer suppliers), better insight in supplier performance, and more insight in (best) market conditions.

11.5 – Summary

The procurement domain has been selected as the focal point for Part IV of this report. Here, all theory, ideas and concepts which are collected so far are combined and applied to the procurement area.

Procurement is a logical area to focus on, i.e. also for EMS companies that concentrate their efforts more and more on procurement and with about 80% of costs of goods sold come from materials sourced from suppliers. Cost savings at the supply side of the business go directly to the bottom line.

The procurement domain consists of different steps, the first three (*specify*, *select*, and *contract*) relate to the strategic sourcing process, and the last three steps (*order*, *fulfillment & settlement*, and *evaluate*) are more operational. However, not all buying activities follow the same steps, logical, since all items can be categorized in different categories. These categories, first introduced by Kraljic, have their impact on supply chain collaboration as well. Strategic items (high profit impact, high supply risk) are treated different than the less critical items – and are by nature candidates for close supply chain partnerships, and collaboration.

Software to support the procurement process exists since the early days of automation. The software solutions can be divided in mainly three categories: support of the *sourcing* steps, support the *buying* steps, and procurement *analytics*.

Chapter 12 – Collaborative Procurement

In this chapter the procurement domain is combined with the content from the earlier parts of this report. Therefore attention is paid to the way procurement is performed in the Electronics industry, to the relationships with the value disciplines and the planning levels, as a match is made with the software support.

12.1 – Procurement in the Electronics Industry

The key business issues the Electronics industry faces – see Chapter 3 – have their influence in the procurement process. The decreasing prices require a good management of the inventory, and just-in-time ordering. However, the parts generally do have a long supplier-leadtime, and this results in a need for good forecasts, which are linked with the procurement function (see for example Figure 11.5).

The problems with multiple-children Bill-of-Material's (BOMs), as described in Section 3.4 and Appendix 5, have their influence in the procurement process as well. Being able to produce the same end-product with different BOM's makes it possible to safe costs when smart optimization occurs. Making use of (up-to-date) supply market knowledge – on price, availability, and delivery date – makes it possible to make the right decision here. The information system in charge preferably is pro-active and guiding in its recommendations.

12.2 – Collaborative procurement process

12.2.1 – Value discipline influence

Value disciplines have their influence on collaborative processes, as i.e. Parts II of this report shows. The procurement domain is connected with the other core processes in manufacturing (see Chapter 4), like there are *production* and *logistics*. Nevertheless, also procurement is performed differently when the strategy is different. Feedback from Electronics' companies supports this theory. Operational excellent companies are likely to focus primarily on low cost standardized transactions with a limited number of supply partners for their critical components, where they want to squeeze out the costs of commodity buying – and therefore perhaps turn to marketplaces, where product leaders work with a dedicated supply partner network and integrate procurement with design. Customer intimate companies primarily focus on customizability in their procurement and they work with suppliers with a real service orientation. Figure 12.1 illustrates this.

The different procurement steps (as there are specify, select, contract, order, fulfillment & settlement, and evaluate; see Figure 11.2) are the same whatever the leading value discipline is. However, a value discipline can influence the focus on some of these steps.

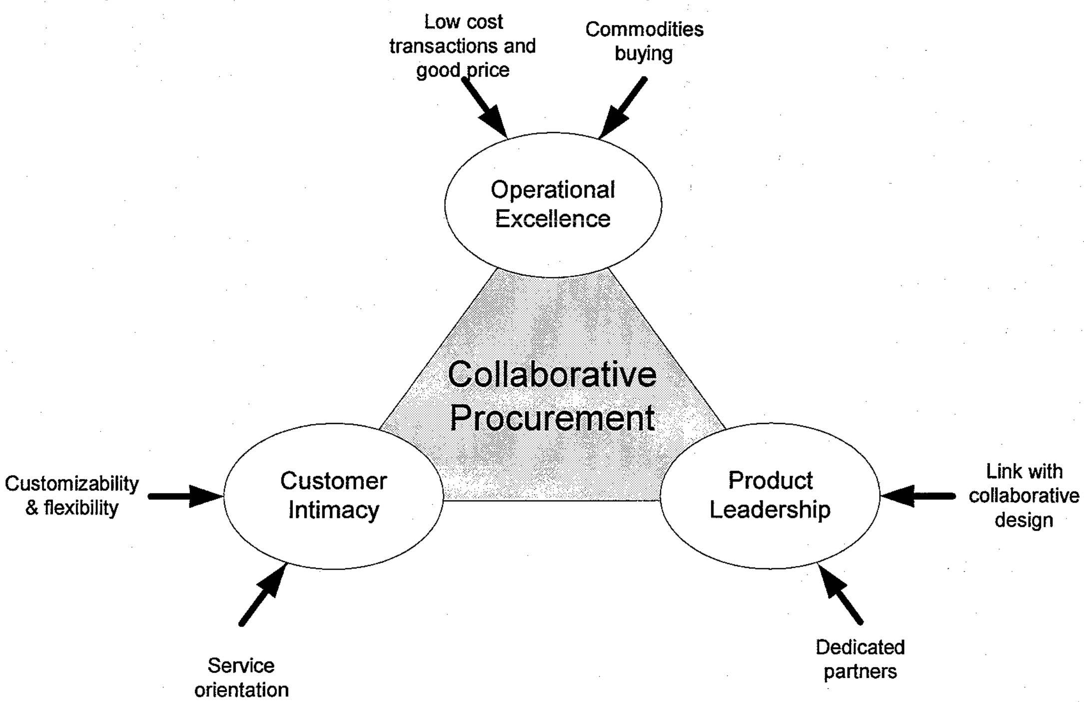


Figure 12.1 – Collaborative procurement

Operational excellent companies thrive to combine the procurement function primarily with the production and logistics function (see for example [73], describing the procurement situation at Flextronics – which is a perfect example of operational excellence), where product leaders try to combine procurement with research & development (or design), and customer intimate companies do generally perceive procurement as non-critical to their business – since they focus on the customer faced processes. However, from a theoretical standpoint it could be worthwhile to integrate procurement narrowly with sales, production and the other fulfillment processes, also for customer intimate companies – as the collaborative order fulfillment planning concept (see section 7.4) shows.

Some of the major procurement problems Flextronics has to face, are, according to [73]: (1) local buyers ignore global contracts, and choose their own suppliers; (2) local buyers do also buy from non-strategic partners (from whom they do not get volume discounts); (3) the corporate procurement (control) department is currently not able to react upon discounts as are given to local sites (to turn that into global contracts). All these issues are inline with Flextronics' focus on operational excellence to reduce unnecessary costs wherever possible, and to smooth the procurement operations.

12.2.2 – Planning level influence

The detailed look at the procurement processes, as can be found in section 11.3, shows that procurement is a complex domain of separate tasks (see for example the Figures 11.2 and 11.3). Before a product can be ordered, many other things need to be arranged first. Orders are mostly placed against a contract. The contract as such is the result of a sourcing process; a selection and contracting arrangements process with the possible suppliers. And that could be the result of a search process for possible suppliers with the right qualifications. The (operational) ordering process has a much larger frequency of usage, than the more strategic search for suitable suppliers.

Making a diversification between three planning levels is absolutely an essential element in the procurement domain. It provides insight in the way the processes are performed – such as frequency of usage, selection freedom per step, communication with partners – and helps in thinking about the role for software support, as will be shown further in this chapter. See also Example 6.2 given in Chapter 6.

The operational tasks are best helped with smart automation (such as exception handling functionality – see also the concept as defined in Chapter 10), since these tasks are highly repeatable, provide a (relatively) low added value, and consume much time. Much can be done to lower the *transaction overhead costs*. The strategic tasks, which do have more influence on the total procurement costs, try to reduce not only the transaction overhead costs, but also the (larger) *noncoordination costs.* Therefore it could be safely stated that: The higher the planning level, the larger the possibilities are to squeeze out costs. At the operational level, only the costs that relate to the actual transaction can be reduced, at the tactical and strategic level much more reductions are feasible (see also Section 2.6). Better contract negotiation (e.g. a company wide contract against lower prices), the search for alternative suppliers, and collaborative initiatives such as collaborative design (which closely relates with the procurement domain), are examples of approaches that can bring some real cost reductions. From the perspective of an individual company, or even from a complete supply chain perspective; the collaborative design process, for example, may positively influence all supply partners.

12.2.3 – Three dimensional view

The three dimensional view of collaborative processes, as is shown in Figure 6.4, explains that the value discipline and the planning level, directly influence the business functions and the collaborative processes; and therewith build the foundation for a focus on certain business functions, in this case procurement. Procurement becomes one of the instruments in a collaborative process, which is executed together with business partners. Table 12.1 gives an overview of some issues that may be important in the execution of procurement for companies with a different business strategy.

Table 12.1 – Procurement focus examples

	Product leadership	**Operational excellence**	**Customer intimacy**
Strategic level	Integrate procurement with design	Search for cheaper alternatives Negotiate better contracts	Align contracts with service objectives
Tactical level	Monitor for updated parts	Buy commodities at the spot market	Monitor service performance
Operational level	Fast transactions	Low cost transactions (automated)	Flexibility in order possibilities

The collaborative processes earlier in this report referred to as 'collaborative planning & visibility' and 'collaborative order fulfillment planning' have a major procurement component. In especially the aspects of *information visibility* (before and after ordering) of inventory-stock and orders, and *negotiation capabilities* are important elements that influence the procurement domain. These elements make it possible for companies to widen their influence and get more grip on what is happening beyond their own corporate borders – and so it reduces supply chain costs (of all different types, but i.e. of the noncoordination type).

12.3 – Collaborative procurement software

12.3.1 – The theory

Chapter 6 and 8 introduced the idea to automate as much operational tasks as possible, and to support decision making at the more operational levels. In today's practice. most procurement organizations devote a majority of their time to non-strategic, non-value added activities [107], i.e. activities other than sourcing, negotiating, contract management, and supplier relationship management. Much of the time is spent on answering basic supplier inquiries, and labor-intensive activities to expedite and defer purchase orders, obtain advanced shipping information, process order acknowledgements and change orders.

Figure 12.2 (partly based on: [22]) shows that it is much more valuable to devote more time of the procurement staff to the more strategic processes, simply while the influence on procurement costs is higher at the strategic planning level than the influence of decisions taken at the operational level. Today, much time of the staff goes to the operational steps. Buying and problem solving (or fire-fighting) could even consume up to 95% of the staff's time [86].

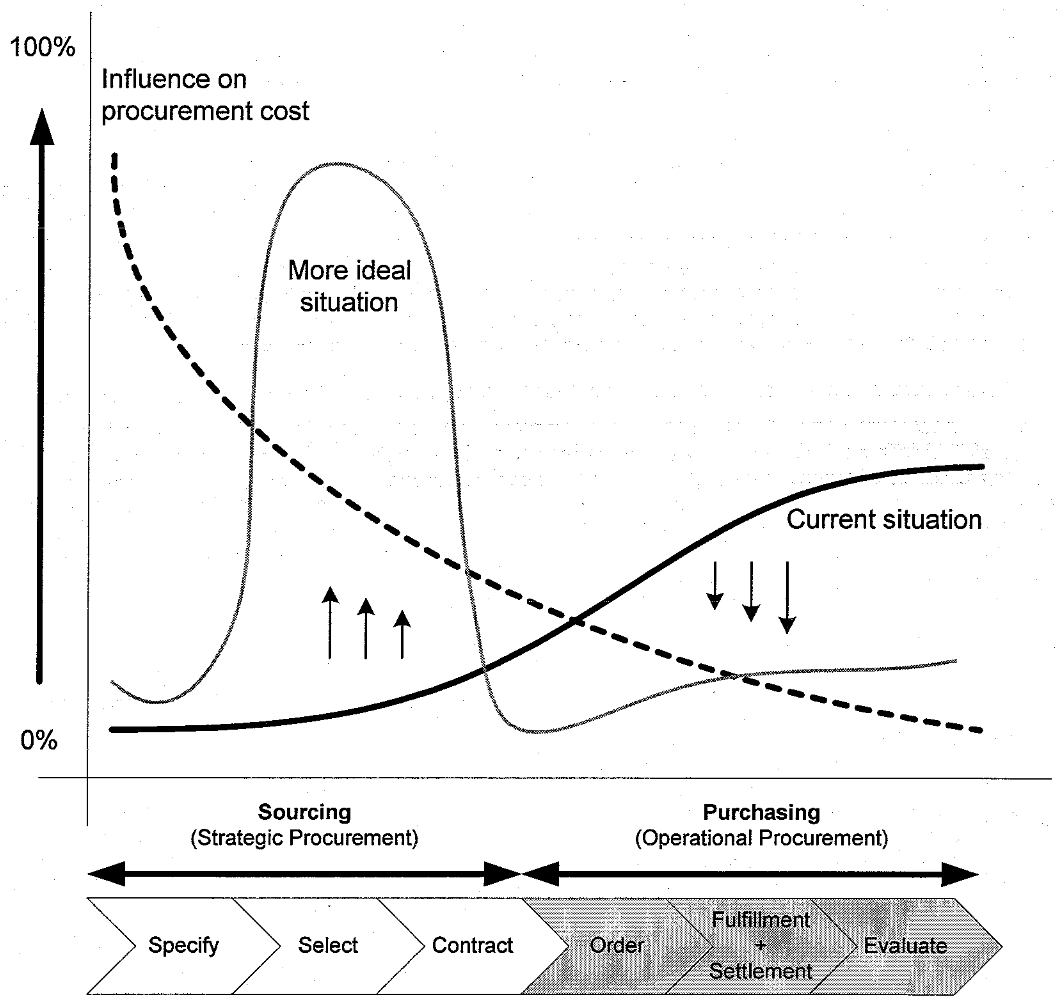


Figure 12.2 – Distribution of time and involvement of procurement professionals

12.3.2 – The solution

Software needs to be the facilitator to help companies forward. In essence, software eases or automates the (administrative) steps in a process, therefore the process takes less time to fulfill, and can be executed more often, or is simply performed better.

Operational processes need to be automated as much as possible, through flexible workflow management systems, good integration technologies (EAI (Enterprise Application Integration), B2B (Business-to-Business) / internal and external) and exception monitoring and handling functionality (see Part III of this report). The exception monitoring tools filter for situations were human intervention is needed, and adds-value. This way, it frees procurement organizations to let its personnel focus on the more strategic issues. These strategic processes however, are also supported through software. New e-Sourcing software for example, makes it possible to perform the sourcing of the same category of items multiple times a year across many companies, for example, rather than a single company sourcing an item once every two years [1].

These concepts function as the basic design principles for Chapter 13, where some recommendations are collected for the Baan solutions in the procurement domain. These recommendations are not only based upon the ideas as presented here, an analysis of the current technological and functional gaps in the Baan product portfolio is an important aspect as well.

Baan comes from an enterprise information systems background. Its solutions have always been based on transaction processing support, which means: the support of i.e. the operational planning level decisions. Baan's customers use the software to automate their procurement processes.

Some companies active in the procurement software market, however – such as the earlier mentioned FreeMarkets [u16] and ICG Commerce [u19] – follow another strategy. They do not focus on the software support as such, but position themselves more as service companies to support the procurement domain. These companies do have a consultancy background, and have a staff existing of procurement-domain-experts. They support companies top-down, i.e. starting with advises in the area of strategic decision making processes. Furthermore they arrange auctions, and provide advices on software implementations.

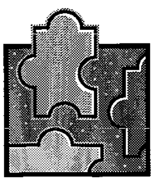
The next chapter does take the focus of the traditional enterprise software vendor. How can procurement solutions evolve, what is needed, and how can the different planning levels be well supported with software solutions.

12.3.3 – Procurement strategy

Procurement software helps to execute the procurement strategy a company has. Therefore the goals need to be defined precisely, so technology can be applied to these goals. This may include bringing in a consulting firm to review procurement strategy and to get a handle on what is being spent and where before deciding what technology to implement [51]. Note that, generally speaking, enterprise software firms are specialized in the operational and tactical domain, and do only provide tools that tough the more strategic domain. That level however, is a specialization as such, and is absolutely more than only information technology.

12.3.4 – Procurement staff

Due to these developments, it is expected [45], [92] that procurement personnel will see a change in their daily tasks. The strategic processes grow in importance, and the daily order processing work will get less; skills related to supplier evaluation and selecting, auctioneering, and negotiation management are needed. Therefore the staff needs to have more insight in business economics and strategic thinking. Since the members of the procurement staff most probably have a different background (in education and skills) [119], it may be very difficult to shift people from the more operational processes to jobs where they get to handle the more strategic aspects.



12.4 – Summary

This chapter combines all the theory collected in the previous parts of this report, and applies this in the procurement domain. The Electronics industries specific business issues, such as decreasing prices, long-supplier leadtimes, and the problems around multiple children BOMs, influence the procurement processes, and require a strong software support.

The collaborative procurement process is influenced by the value discipline focus (or strategy) a company has. Furthermore the three planning levels influence the processes as well. The three planning levels provide insight in the way the processes are performed and gives insight in the way software solutions need to support the different tasks.

In the ideal model, the operational procurement steps are largely automated and optimized through software, where software plays an important role in the support of the decision making in the strategic steps. However, note that this can result in a change in the daily work of the procurement staff – a factor that must not been underestimated.

Chapter 13 – Recommendations iBaan SRM

This chapter lists some suggestions for the iBaan SRM (supplier relationship management) roadmap for the next years. Starting with today's solution, some recommendations are done; both functional and content related. The chapter is concluded with a section on Bill-of-Material (and the use of alternative items) optimization.

13.1 – Current product portfolio

13.1.1 – Baan procurement portfolio

The iBaan Procurement Toolkit was released early 2002. As all iBaan Solutions, it is a bundled solution of different software components with pre-baked relevant content. The iBaan Procurement Toolkit is suited in especially for procurement organizations of large enterprises. Although the solution consists out of separate software products, everything is integrated and connected and large parts of the solution are Internet-enabled.

The solution contains iBaan ERP, iBaan e-Procurement, the iBaan Business Intelligence (BI) environment, iBaan Portal, iBaan DEM, iBaan OpenWorld, iBaan B2B Server, Crystal Decisions analysis tools, and some pre-defined (procurement analytics) content. e-Procurement focuses on indirect material purchasing, and ERP handles sourcing and direct material purchases. The BI tools are there for operational analytics. OpenWorld and the B2B server handle Enterprise Application Integration (EAI). OpenWorld connects the different iBaan applications within the own firewall, whereas B2B server is used to handle the communication with external applications outside the firewall. More detailed product information can be found at baan.com [u3].

Being one of the traditional Enterprise Resource Planning (ERP) vendors, Baan's iBaan solution is mainly focused on the operational steps in the procurement process. The more strategic steps in the process are less supported, although the content as provided with the Procurement Toolkit is focused on analysis at the different planning levels (from the (strategic) management board-level, until the (operational) buyer role).

The Baan procurement portfolio will be extended with the iBaan e-Source product within a couple of months. This Internet enabled solution extends beyond the features ERP offers in the strategic sourcing domain. See [115] for more information.

In 2003, the iBaan Procurement Toolkit will be extended towards a real Supplier Relationship Management (SRM) solution, wherefore many additional components, integrations, and content is needed. SRM contains more than only the traditional procurement domain. For example, it also includes giving suppliers a self-service view of the information they need to see, such as order status, payment information, demand forecasts, and supplier scorecard information [18].

The iBaan SRM roadmap is currently under discussion. The later parts of this chapter provide some insights, suggestions and recommendations that could be of use. Note that it is not a complete list. The issues addressed here include a business case on the operational planning level, some content suggestions, and the relation between procurement and the multiple Bill-of-Material (BOM) and part-number issues as are specific for manufacturers in the Electronics industry. Further research and analysis of software issues therefore is still needed (and recommended).

13.1.2 – Baan's competitors

Procurement is one of the original pillars of ERP. Not unsurprisingly, Baan faces heavy competition from the large ERP vendors SAP [u31], Oracle [u27], PeopleSoft [u28], JD Edwards [u20] and Navision [u22]. They offer more-or-less the same kind of functionalities; generally based on their own ERP platforms.

Strong domain-functionality in i.e. the indirect material ordering and e-sourcing domains are offered by best of breed (BOB) vendors such as Ariba [u2], Commerce One [u7], FreeMarkets [u16], and i2 Technologies [u17]. The largest disadvantages these niche players face is that they simply lack the capabilities to integrate with their (own) applications in other domains, and therefore generally offer stand-alone products. Expensive EAI projects are needed to integrate with the rest of the enterprise backbone.

13.2 – Assessment of ERP Procurement functionalities

13.2.1 – Where business issues touch technology

A high value density, a short product lifecycle, a stringent need-for-speed and high obsolescence rates are some of the most important business issues the Electronics industry has to face (see Chapter 3). Contract manufacturers face low profit margins, have to control their costs and handle all their decisions with care; therefore they even have a larger need for procurement software solutions that help to optimize and reduce costs. These issues – and all other aspects as discussed in the earlier parts of this report – have their influence on the requirements for the procurement software solutions.

Chapter 8 showed a high-level architecture of enterprise information systems. In the enterprise (Figure 8.1) and also the connectivity between different enterprises (Figure 8.2). ERP systems are the backbone, and some other (mainly customer- or supplier-facing) components have been added in the recent years.

Although some analysts sketch a very advanced and highly automated backbone for companies active in the Electronics industry, the analysis as performed in this research-project – i.e. the company input from Omron [u25], and Neways [u23], and some other examples from the Deloitte&Touche [u10] consultancy practice – showed some other findings. ERP systems are in use, but not all available features are used. The use of advanced SRM (Supplier Relationship Management), CRM (Customer Relationship Management) and APS (Advanced Planning & Scheduling) systems is quite rare, i.e. in the smaller companies. Procurement is an area that touches the supplier side at the focal company, and the customer side of the supplier, and has all to do with communication and information exchange between two different parties.

13.2.2 – Identification of gaps

To identify improvement issues for (i.e. operational and tactical) procurement applications it is good to first look at today's status, before combining that with the design principles as provided in the previous chapter. For a simple analysis of some of the current gaps, it is best to exclude all advanced SRM, SCM (Supply Chain Management) and e-Procurement applications in the analysis and to look at a simple ERP – ERP connection (through EDI (Electronic Data Interchange)) between two companies (the focal company, and a supplier), as a business case.

Note that the focus here is on the category of software that supports buying, and not on sourcing software or procurement analytics (see also Section 11.4).

Figure 13.1 shows this, and it gives an overview of the identified pain points. These pain points lie in: (1) The EDI communication itself (batch wise, expensive, low flexible, etc. – see also Section 9.2), (2) The batch-wise planning processes (an issue clearly related to ERP's planning mechanism), (3) The low visibility (within the own enterprise (multi-site), and between partners), and (4) The lack of event management capabilities.

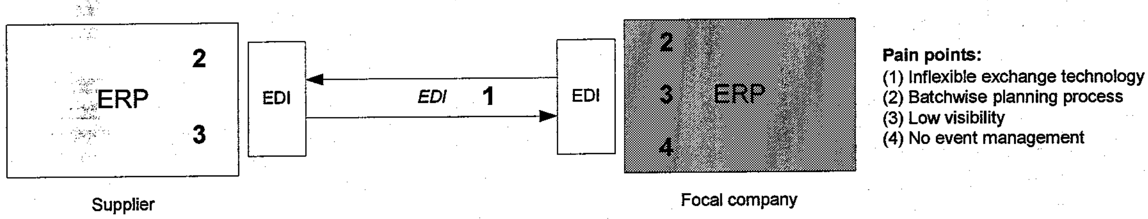


Figure 13.1 – ERP to ERP connection between partners, through EDI technology

All these pain points translate in long time gaps: the ERP planning engine takes time before an order is planned, the EDI communication is batch wise, which consumes again time, at the supplier, the sales order needs to run in the ERP system of the supplier before an advanced reception notice can be submitted, than again the EDI communication takes time, and when the acknowledgement is received, first the ERP planning engine needs to run again. Only than the results of the acknowledgement can be analyzed.

In case the acknowledgement is okay, this is no problem, but in the case that it is not okay, it is a real problem; since it took many hours, or even days before the error got visible in the procurement system. The slow response, and lacking (near) real-time capabilities, than strike with the business issues.

Other research [103] comes to a similar (but much wider to interpret) conclusion: the majority of the throughput time is taken up by information related delays, not by the time required to physically process or transport the products.

13.2.3 – Solving pain point I -> Inflexible exchange technology

EDI communication has three major drawbacks (see also Section 9.2): (1) the batch-wise communication, (2) the inflexibility of the standards, and (3) the inflexibility of the infrastructure.

At first glance, batch-wise communication seems to be the largest drawback, but that is not entirely true. Communication is indeed not performed in real-time, but the interval between or the frequency of communication can be defined freely. In fact it could be possible to transmit the data nearly real-time, for example every ten minutes.

The inflexibility of the standard is a larger problem. The existing EDI standards do not allow any form of change, and therefore a company is limited to the predefined standard. The inflexibility of the infrastructure, with its expensive communication infrastructure is a major problem as well. Communication costs are high, and connecting new partners is a long and painful traject.

Although it largely depends upon the existing (EDI-)infrastructure and usage, a Business-to-Business (B2B) communication platform (such as the iBaan B2B Server) would be the preferable option. A platform like that, integrates with the diverse enterprise information systems (not only ERP), and uses the Internet to connect in real-time with business partners via XML (Extended Markup Language) messages. A flexible and cheap solution, to make the infrastructure more agile and flexible. Note that the iBaan B2B server can also be used for fax and (in an upcoming release) EDI communication. A B2B server can serve as the basis for a Private Trading Exchange (PTX), handling the communication part of such a platform.

13.2.4 – Solving pain point II -> Batch-wise planning process

Today's generation of (enterprise) planning systems work – generally – batch-wise. That means that every so many hours, a planning run is performed, and an optimal planning is made. In practice, such a large planning is generally performed once a week, or (at most) once a day – mostly during the night. This is true for the planning engines of ERP systems, as it is true for most APS systems.

Some APS systems however, have capabilities, to perform optimization based upon the data from the last planning run and all changes that occurred and have been captured in the meantime. Therefore, using APS systems in the sales and procurement processes may be beneficial. In the Baan product portfolio, this could mean using the iBaan Order Promising application in the sales process.

13.2.5 – Solving pain point III -> Low visibility

The visibility issue consists of two components: a low visibility in the *own operations* and own (internal) production network, and a low visibility between *supply chain partners*.

Low visibility in the own internal production network is still a problem (as the meetings with companies such as Omron, Neways and Flextronics show), although many automation and software initiatives have been enrolled over the last decades. Companies still face the situation that they order material they have in over-stock at another location. In the Electronics industry's practice that may result in ordering material, and keeping the same material at the other site as inventory which may become obsolete or useless because of material characteristics – such as percentage of moisture. Multi-site overseeing planning applications could be of great help here.

Another interesting aspect is the low visibility between supply chain partners. In the middle-long or long term that translates to joint-planning and forecasting, an area which is generally recognized and discussed before. Operational decisions that have to do with partner-visibility are, strange enough, not that common supported.

The Baan sales (and APS) applications have the functionality to initiate availability, or order promising checks. Therewith, a customer or sales representative is able to check for availability, price, and delivery dates (now and in the nearby future), and can use that information in its decision to order, or not. Strange enough the procurement applications (i.e. ERP Order Management; e-Procurement has some basic functionality) do not have the functionality to initiate an order promising check in the sales-systems of the supplier(s).

It would be very logical that a company checks for availability, delivery date, and perhaps even price, before it actually places an order (for all kinds of items). To select the best supply source, in case a company has different (preferred) suppliers. Or, to use the results for own planning purposes. A third possibility could be – in case different supply options are fed back – to chose the most attractive option.

Generally speaking there are three phases, see also Figure 13.2: (1) the actual request to the supplier(s), (2) the response(s) from the supplier(s), and (3) the decision-making based upon the responses as collected and the own planning. These phases are inline with RosettaNet's definition of PIP 3A2 [u30].

Please note that visibility even increases in importance, when the delivery date comes nearer. It is important that suppliers exchange order-status information with their customers (the focal company). For example to keep track of production schedules, expected delivery dates, and production or distribution related problems. This information than can be included in the planning schemes of the focal company, and (important) all exceptions can be identified proactively and in an early stage.

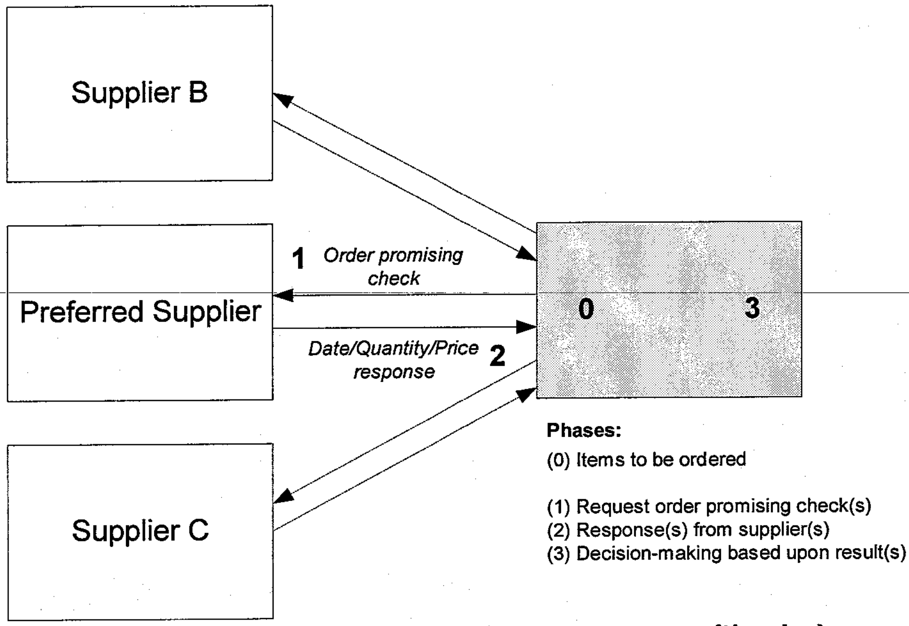


Figure 13.2 – Order promising (connecting procurement with sales)

13.2.6 – Solving pain point IV -> No event management

Lacking event management was identified as another major struggle. Currently monitoring functionality is lacking, and exceptions can only be found after a complete planning run has been performed, and not at the moment the (positive or negative) acknowledgement comes back. Identifying the exception is one thing; even more important is the (automated) workflow to resolve the exception and the use of business intelligence to do so. It raises questions such as: 'Perhaps the planning could be changed?', 'Delivery schedules can be adjusted?', 'Order somewhere else?', 'Check for availability with other suppliers?', etcetera. See Chapter 10 about the Proactive Resolution Broker for an illustration how such a solution may look like.

13.3 – Other functional recommendations

Next to the solutions for these identified pain points, it could be valuable to apply the idea of the Proactive Resolution Broker (as introduced in Chapter 10) in the procurement domain. Therewith problems can be discovered proactively, the staff could focus on the situations that request real attention, and workflow management helps to smooth the processes. Such a solution can be applied especially for buying support, but could be useful in the strategic sourcing domain as well – for example to compare data, handle requisitioning processes in a structured manner, and to learn from the past.

Standard initiatives are important to follow. The RosettaNet specifications in the order management domain (sales and procurement) are already wide developed and are important to include in the offering. Initiatives like the OBI Consortium [u26] are also interesting to follow; the OBI Consortium tries to set standards for sharing catalog information with customers and suppliers.

Realizing the 80-20 rule as shown in Section 9.1.3, a Private Trading Exchange (PTX) infrastructure could be ideal for the connections with the (larger) partners. The PTX cannot only function as a platform to exchange just orders, but also as the basis to share more information with suppliers such as forecasts, designs, and performance information. Smaller partners can then be serviced with a simpler portal environment.

A further integration between the sourcing and (manufacturing) planning domains is recommended. Although both domains have a different focus, in the end, both try to optimize the same. Sourcing activities try to do this before the contract is settled, and manufacturing planning, which mostly drives the purchasing process tries the same after the contract is settled. An integrated approach, where information is shared between those until now separate domains, can de very beneficial since optimization than can take place with insights in the total landed costs. This is also recognized by [86].

13.4 – Content recommendations

13.4.1 – Lead-time responsibility

The static nature many enterprise information systems have – as is identified in Section 10.4.3 (and Example 10.1) – has its influence in the procurement domain as well. Delivery lead-times for example get entered once, and are hardly updated later anymore. Quite strange, since these parameters function as the basis for many calculations [107]. Reliable delivery times are the basis for optimal decision to be made by ERP and APS planning systems.

In Chapter 10 two different solutions are suggested: (1) Suppliers update their expected delivery times on a regular basis directly into their customers systems. (2) The customer, the focal company, monitors the performance of its different suppliers and (automatically) updates its enterprise systems.

It is always useful that the focal company monitors its suppliers' performance, to control the details of the Service Level Agreement (SLA).

13.4.2 – Supplier benchmarking

A closely related area is the area of supplier (delivery) performance & benchmarking. Giving suppliers insight into their performance towards their customer (the focal company) can help to improve the relationships. Business intelligence and data-warehouse information can be presented via a supplier portal, and the information can be used to check the performance. Continuously tracking and benchmarking performance, therefore is seen as one of the crucial elements of supply chain management [36]. Its results could be used to form an appropriate supplier selection mechanism.

13.4.3 – Conference and decision platform

Today, many contract manufacturers have a weekly meeting with their suppliers (and customers) to discuss their business. During these meetings the partners discuss issues such as: changes in forecasts, performance issues, supply conditions, new product introductions, operational problems, etcetera. Much of the material needed during such a meeting is collected every week again. The meetings generally lead to decision taking, which impacts their operational activities during the coming weeks.

A (supplier) portal could be used to streamline such conference sessions, and function as the basis for all information. Best when it is fed automatically with information, and support the decision taking process intelligent [10]. A shared management information system or dashboard – and the platform to show Key Performance Indicators (KPI's) and reports.

13.4.4 – Information to share with suppliers

In another Eindhoven University of Technology research project [53] the following issues were identified as other issues which could be interesting to share with suppliers; therefore these could be candidates to include as content in an extended SRM solution: (1) the ability to change basic account information (such as addresses, names, etc.); (2) designs, standards and norms; (3) company news; (4) the ability for suppliers to post improvement suggestion.

13.5 – Multiple BOM aspects

13.5.1 – Two issues to manage

The problems for manufacturing companies in the Electronics industry around the article numbers and multiple Bill-of-Materials have been addressed earlier (see for example Section 3.4 and Appendix 5). It can be concluded that these companies have two main issues to manage (next to the other issues they need to manage, of course): up-to-date item information, and optimal BOM choices. Both do absolutely relate to the procurement domain – and have their influence on a collaborative software solution.

Up-to-date item information is important to keep track of different alternatives, 'What is out there?'; to get insight in inventory (own inventory, and inventory statuses at suppliers), 'What can we use?'; to keep track of prices, 'To what price?'; and to understand the delivery times, 'When can I have it?'. Baan's competitor i2 Technologies (see [u17]) offers its Electronics industry customers an i2-controlled central reference catalog database referred to as 'i2 Content', where knowledge about items, parts and components is kept up-to-date (for millions of different items). This system can warn its users also when parts are likely to become obsolete soon. Customers are paying i2 for this service.

Note that the United Nations recently has started a project under the name United Nations Standard Products and Services Classification (UNSPSC) [15], [u37]; a standard, for identification and classification of products and services. It helps to find new products, or to view similar products (alternatives), as it could help to analyze spending. Interesting to monitor the progress of this standard and its application.

Insight in, and understanding of item information is important to make optimal BOM choices. Inventory information, current stocks, market prices, obsolescence information, machine and resource capacities, physical characteristics of the products, etcetera, can all influence the choice for a certain BOM to build the product with. Due to variations in those different functions there will not be one single best choice; the proper choice will vary every day, and therefore optimization can be beneficial here. As such, BOM-choice-optimization has parallels with the Collaborative Order Fulfillment Planning concept as shown in Section 7.4 (minimize total landed costs). At the same time, the supply visibility issue does relate with the Collaborative Planning & Visibility process as detailed in Section 7.3.

13.5.2 – Optimize and gain

Manufacturing companies in the Electronics industry face very low margins as is shown earlier, and can be found in Appendix 4. Controlling the issues as described here can result in lower cost manufacturing since cost savings can be reached in the different areas: lower parts prices (since prices are monitored, and the cheapest alternatives will be bought), less obsolete materials and stock reduction of parts (since obsolescence is monitored, and remaining stocks than will be consumed first), inventory reductions (which results in lower influences of price-reductions), better and smarter usage of capacity and resources (capacity is used where its available – and not simply scheduled), and smarter manufacturing which may result in faster production and delivery.

13.5.3 – Software

As part of the LeanWare solution, Baan already offers a software product – named iBaan MCB Optimizer – that is capable to perform a basic optimization on alternative BOM choices. Basically it is capable to locate inventories (which are not allocated, not used, and therefore risk to become obsolete soon) and to try to re-plan these materials in new orders. However, BOM optimization can go far beyond only this reuse.

Interesting extensions to build, could either be in the SRM/procurement (supplier related) and the SCM/APS (internal planning) domains. Related to SRM are issues such as price monitoring of (possible alternative) items, quality issues, supplier relationships, possible alternatives as included in the contracts, and pro-active recommendations for alternatives (other suppliers, and/or other items). Monitoring these issues (for example via PTXs, B2B marketplaces/catalogs, or services such as i2 them offers – note here the advantage of a standard solution as the UN is working on) could be very beneficial; since it impacts the buy-decision, the manufacturing process afterwards, and could be interesting for cost reductions (mainly of the *non-coordination costs* type). An APS related extension would be a coupling between capacity (of machines and other resources) and items to use – since different BOMs could require other production resources.

A coupling with Product Lifecycle Management (PLM) systems could be interesting to consider. Furthermore, this BOM optimization area could be an interesting area to apply the Proactive Resolution Broker concept, which is introduced in Chapter 10. This enterprise enabling technology layer could help to monitor dataflows, react upon changes, and take optimization decisions based upon smart information.

Last, but not least, this BOM optimization area could be closely linked with a conference and decision platform, which is suggested earlier in this chapter. When the software discovers interesting opportunities or trends (even beyond specified alternatives as are in the contract), the platform could be used to interact with suppliers, and to collaborate with them to improve the business.

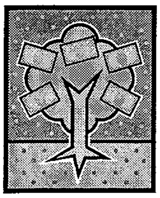
13.6 – Summary

The models developed earlier in this report turn out to be useful to look at software solutions. In this chapter some concrete suggestions are done for the iBaan SRM solution roadmap.

A case of an ERP-ERP connection between two companies, which have a buy-sell relationship works as an illustration of the current status. It shows some basic issues which are still not addressed in today's procurement solutions such as problems caused by inflexible information exchange technology, batch-wise planning processes, low visibility (in own operations and in suppliers' systems), and no event-management in the procurement process. Some of these issues can be solved with available technology, others not – such as, for example, the impossibility to initiate an ATP check at a supplier's system before actually ordering.

Next to the issues addressed in this case some other ideas will be listed, both functional and content related. The last section of this chapter is on BOM optimization and the use of alternative items. It turns out – at least for companies in the Electronics industry – to be a very interesting area, where software could absolutely help to improve the business. The current BOM optimization product, in Baan's portfolio, does not include any procurement related issue. However, procurement decisions need to be a central and integral part of such an optimizer.

Part V – The End or the Beginning



Part V – The end or the Beginning

In this part the contents of the rest of the report is evaluated. Furthermore some future looking thoughts will be discussed. Part of this is a collection of research recommendations.

Chapter 14 – Evaluation

This short chapter looks again at the problem definition and research questions this project has been started with, and evaluates them.

14.1 – The problem definition

This research project has been initiated in December 2001 with the following problem definition:

How should enterprise software vendors change their software products to help companies in the Electronics industry in confronting their collaborative challenges?

Reevaluating the question right now, it may be concluded that although the problem definition has indeed been the driver for the entire project, it has been less focused on software than originally intended, and therefore has been more process focused. It starts with insight in the business issues, before the supporting software products/architectures/solutions can be discussed. Unfortunately, the objective to do some pilot development was not feasible to execute in the project.

14.2 – The research questions

14.2.1 – Part I: background

The research questions 1 to 3 (see Section 1.2.2), which were asked to widen the knowledge and understanding of the Electronics industry, SCM (Supply Chain Management) and the collaborative commerce field, were answered from a high-level perspective. Mainly through the use of literature study, discussions with experts and some concrete input from companies out of the Electronics industry. Unfortunately time was lacking to validate the conclusions and hypotheses from Part I (the same is true for the other parts) through proper survey research. However, feedback from different companies showed that the basis could be not too far from the truth. The research questions were of good use, and answered properly.

14.2.2 – Part II: collaborative processes

Part II of the report focuses on collaborative processes. The questions (4 to 6) were properly answered, but question 5 has been answered in Part I already. The other questions have been interpreted widely, and lead to the detailed descriptions of some examples of collaborative processes, which can be found in Chapter 7.

14.2.3 – Part III: collaborative software

The research questions 7 – 10 correspond with Part III, and center on how software environments have to handle the collaborative challenges as defined in the previous parts of the report. A basic analysis of some of today's enterprise information systems has lead to the design of an inter-connected layer of enterprise enabling technologies that is currently lacking, but an essential element for companies in a collaborative environment. This part therefore did reasonably well answer question 7, and 8. Question 9 and 10 were only partly addressed – more research on collaborative software architectures is therefore strongly recommended (see also Chapter 15).

14.2.4 – Part IV: procurement

No research questions have been defined around Part IV, on procurement. Procurement functioned as the research area in where the earlier developed theory and concepts could be validated. Furthermore, it has lead to some software recommendations for the procurement domain.

14.3 – Summary

In this chapter the original problem definition and research questions return, and are evaluated. It turned out that the problem definition has been useful, but that the project did not primarily lead to software recommendations, as was the original intention.

Most research questions as defined in the beginning have been of great help, and have functioned as the foundation for the report and its structure.

Chapter 15 – Discussion

This chapter concludes the report, and starts with a discussion of the current business situation. In the eleven months this project took, quite some things changed. The market has slowed down, and predictions for the future have been downsized. However, realism has arrived, and collaboration does have a future.

The later parts of this chapter discuss the concrete application of this report, and suggest some interesting areas for further research from both a business model and an ICT (Information and Communication Technology) perspective.

15.1 – Business situation

15.1.1 – Hype

A lot of hype has been created in the last years – by analysts, consultants and software vendors – around themes such as e-business, Supply Chain Management (SCM), Customer Relationship Management (CRM), e-Procurement, and more recently Supplier Relationship Management (SRM), Product Lifecycle Management (PLM) and collaboration or c-commerce.

This has its positive and negative sides. On the one hand it is positive that these subjects get so much attention. Hype is actually there since it is an interesting and promising area. On the other hand it also creates confusion and distrust i.e. against those creating the hype. Due to the worldwide economic downturn, and the dot.burst from 2001, companies have become very critical towards the enterprise software market. The golden trees that got promised, Return-of-Investments (ROIs) of only a couple of months, and even a whole new economy concept, are still fresh in mind. Now, more than ever, investments in new enterprise software implementations need to be justified with a strong business case and an acceptable ROI. The Internet and software industries have finally matured, and are in the state of transforming into normal businesses.

Perhaps a paradoxical situation, but the economic downturn does also have its positive side effects. Like there is the stringent need to cut out (unnecessary) costs. More-and-more (i.e. innovative) companies start to discover that close collaboration with their supply chain partners can actually result in considerable financial savings. Examples of these innovative companies that pilot new business models and software technologies can be found in almost all industries; see for example [23], [54], [56], [71], [88], [123]. Key is that those collaborative initiatives cannot gain real traction without the use of modern information and communication technologies (ICT). However, ICT does only have the role and function to support the business strategy [95].

15.1.2 – Realism

Collaboration could have been brought to the world as just a new hype. However, there may be no single doubt that it is here to stay. The area of collaborative business has a bright future. Real benefits are underway, but currently still largely uncovered. This report, for example, shows that there is a strong business case for collaboration with supply chain partners. It is actually a natural step. Costs have been squished out in the own (internal) organization, now it is necessary to look beyond the corporate border and to optimize operations in the larger supply chain. Is all this new? No, of course it is not. The new thing is that now, finally, the first suitable enterprise information systems become available that enable information exchange and offer applications that can be used in a shared manner with business partners.

Many of the hype-stories (i.e. from analysts, such as the Gartner Group, AMR Research, Forrester, Aberdeen, etc.) tell the business world that collaborative business is just a matter of years away, and therefore pilot-projects need to be started as soon as possible. However, these messages do not really show a large realism.

First, the starting point is wrong. These reports do consider an as-is state in the industries far from realistic. The research in this report had the Electronics industry as a focal point. Although the Electronics is an industry with a high adoption rate of new business models and enterprise software, performed business cases showed that the real implementation rate of advanced software solutions was far below expected; which is inline with other research (see for example [101]).

Second, it is important to understand that supply chain projects are not something from the last two or three years. Over the last decades many initiatives have been started already to improve supply chain performance; these initiatives include for example Electronic Data Interchange (EDI), Efficient Consumer Response (ECR), and Vendor Managed Inventory (VMI) (see also [88]).

Third, it is important to realize that developments, in management, the design (and architecture) of enterprise software, and changing business models do not go that fast as some do state. Fourth, a downturn as is faced in the economy right now does generally slow investments, especially investments in capital goods and technology. A fifth problem is that collaborative initiatives are not that easy to implement, since business partners are involved in the implementation (and execution), and it really hooks up with the (new) business model.

15.1.3 – Time to develop a vision

ICT has become an integral part of doing business; therefore the development of new collaborative business models needs to go hand-in-hand with the development of new enterprise software systems and architectures [42]. No longer, enterprise software can be simply bought from a vendor, implemented by some consultants, and maintained and changed by the (internal) ICT department. To develop these new (collaborative) business models and software solutions the involved parties need to bundle their power, share their efforts, and collaborate to build tomorrow's solutions. Enterprise software vendors therefore must go out to their partners and customers and integrate them in the development projects.

For the longer term, the focus needs to be on vision development. This long-term roadmap should function as the basis for the separate product (or solution) roadmaps. These roadmaps are not built once and than fixated; no, these roadmaps function as a general guideline that gets updated regularly with new insights and visions. In the short-term, pilot-development may be a useful instrument to try new principles and insights.

15.2 – This report

15.2.1 – Related research

Value discipline thinking functioned as the basis for this research – so centering company strategy in the analysis of collaborative needs. Recently, others have recognized this as well. Strategic Consultants from GartnerG2, for example, suggest to use the value discipline concept as the basis for designing business models, enterprise information systems, and the operational processes. Researchers [21] from the Center for Strategic Manufacturing DMEM from the University of Strathclyde, Glasgow, UK, follow the same approach as used in this report: the combination of value disciplines with business functions. It is interesting to compare their insights and ideas with the work as presented in this report.

The *Electronics* industry and the role of *Electronics Manufacturing Services* providers (EMS) herein have now caught the (research) attendance of Academia. A recent Stanford University publication [73], for example, details a Flextronics business case. Other examples are [10], and [36]. It has become clear that the Electronics industry is an industry that already has many forms of collaboration and coördination in its supply chains. Combined with the high adoption rate of new technologies, this is an interesting industry from a research perspective.

For enterprise software vendors it is important to look at everything what has to do with *collaboration* and c-commerce. Recent (Swedish) survey research [101] shows that manufacturing companies that make use of Enterprise Resource Planning (ERP) systems are actively searching to expand their ERP systems in the areas of supplier and customer connectivity. According to the survey, the need for collaborative extensions is significant larger than the needs of these manufacturing companies for, and interests in, CRM, Advanced Planning and Scheduling (APS) and Business Intelligence (BI) systems. Interesting is that these surveys show, that companies that have (heavily) invested in ERP technology are most likely to build their collaborative initiatives on top of the (ERP) platform they use right now. They do not see ERP as 'just another component', as many Analysts envision, but as the basis for future enterprise systems.

15.2.2 – Application of the report

This report takes a systematic approach to find opportunities for collaboration in the Electronics industry (i.e. from the standpoint of an EMS provider). The Electronics industry, with its different stakeholders and business issues is introduced. Supply chain management and collaboration between supply chain partners in this industry are of great importance. This knowledge is combined with modern insights around business strategies – i.e. value disciplines – and so it becomes clear that there is not one single standard method of reasoning. The need for collaborative software solutions varies with the chosen focus and strategy. A research matrix shows five areas where collaboration could be of great importance. These areas are further detailed in a process description, where the influence of planning levels is recognized as well.

Later on in the report, some pain points for new collaborative initiatives in today's enterprise information systems have been identified. The subject of enterprise integration is reviewed thoroughly and a new concept, referred to as the Proactive Resolution Broker, is introduced. It is a model for a new layer of enabling technologies that are necessary in collaborative environments. The procurement domain was used to apply all collected theory, and to analyze the existing software solutions and to support that with some concrete recommendations for improvements.

Target groups for this report are:

- Companies in the *Electronics* industry (EMS providers, but also OEMs (Original Equipment Manufacturers) and suppliers) can use it to figure out how to design their collaborative processes and strategy, based on their specific business issues and their competitive strategy. Furthermore it could provide some insights in the requirements for their future enterprise system architecture.
- It provides the *academic community* with a better insight in the way contract manufacturers function in their supply chains, how changed environments request different collaborative processes, and how all this relates with enterprise software. It could be an interesting starting point for further research.
- For enterprise software vendor *Baan* almost everything that is covered in this report is relevant. It could be of help in developing new (collaborative) software solutions that target the Electronics (or another) industry, as it helps to position the current products and set out the strategy for the future. The concrete recommendations as done could be valuable roadmap input; mainly for the iBaan SRM and EET/RTEF teams.
- Consultancy firms operating in these markets, such as *Deloitte&Touche*, can use the report as a basis for their future work. Furthermore it could be used as comparison material to monitor different enterprise software vendors in this area.

Further research could be initiated around a couple of different themes. The next two sections list some suggestions that might be considered. The first section focuses on research on the business models, where the second describes the ICT related suggestions.

15.3 – Further business model related research

15.3.1 – Value discipline thinking

This project used the idea that value discipline thinking has its influence on collaborative process specialization, but no detailed further research on value disciplines has been executed, since it lays somewhat behind this project's scope. However, more research on value disciplines could be interesting. Questions to answer could be: 'How do companies (in the Electronics industry) choose their value discipline focus?'; 'How do companies (in the Electronics industry) execute a discipline?'; 'What have today's (Electronics') companies actually chosen?, and Why?'. Although Treacy and Wiersema [112], [113] did originally define only three value disciplines, over the years many authors have suggested that there are probably more than three. Bititci et al. [21], for example, identifies six different disciplines (he actually splits each of the three original disciplines in a soft and hard variant). According to others [42], [48], *brand mastery* is the missing value discipline. Brand mastery is based on excelling in controlling customer perceptions of the company's products and services. Nike is a perfect example of a company with a focus on 'brand mastery'. Others speak about *network orchestration* as a new discipline.

15.3.2 – Network orchestration

Network orchestration is seen as a strategy where companies gain competitive differentiation through controlling and organizing the supply network [23], [25], [69], [76]. The company orchestrates everything and connects the large network of suppliers, manufacturers, and distributors. Some of today's best practices in industry do have a network orchestration role – such as Cisco, Gateway, Dell.

Opportunities to take up the network orchestration role are largest for companies with a strong position in their supply chains; and that are not many. For the Electronics industry such a role therefore would be most likely for the strong suppliers (e.g. Intel), and large OEM's (e.g. Cisco, Nokia). But the larger EMS providers could be candidates as well, since some of them (e.g. Flextronics, Solectron) have gained a strong position in their industry as well.

Key will be the management of processes. Information technology can play a supportive role and ease the processes by automating much of the previously manual steps (such as telephone calls, all kind of checks, contract monitoring, etc.). The concept of Collaborative Order Fulfillment Planning, as described in Section 7.4, has much in common with the ideas of network orchestration.

Another interesting (and related) development are the new insights gained around the Consumer Order Decoupling Point (or CDOP-II). See also [67] and the last part of Appendix 2.

Network orchestration as such, the impact it has on the structures in the (Electronics) industry, and the corresponding software solutions to support this, could be interesting topics for further research.

15.3.3 – Trusted third party

There might be an interesting role in future business models for trusted third parties that are able to enable change and information exchange in an industry, as was suggested some years ago already by Wouters et al. [123]. The trusted third party coordinates collaboration in the network. That is inline with the concept of division of ownership, power, and loyalty within the network, as introduced by Kornelius [69]. The individual goals in a supply chain do differ, but – at the end of the day – it is important for all parties that supply network efficiency and service get optimized, separate and independently of how the other phases are organized. A trusted third party may help overcome some of the hard and soft struggle points: through its independence it could have a bridge function, as it could be the actual data exchanger.

Trusted third parties as described above may have a large influence on future business models. For example in relation with electronic marketplaces, as [122] does suggest. Therefore it may be useful to initiate some more research in this area.

15.3.4 – Research model

The framework used for this research consists of two different axes: one showing the three value disciplines, and the other showing nine business functions. Of course there can be discussion whether this is indeed the ideal model for this research. It could be discussed if the combination of these two axes is the right one; and it could be discussed if the three and nine elements are the right ones to put on each axis. The first question is the hardest to answer; but since other sources [21], [42] use about the same approach it could be considered as an appropriate method. The question if these elements are the right elements may be there as well, but is not that relevant. In this project nine business functions were used, but it had been possible as well to use the four (or five) business functions from the Supply Chain Operations Reference (SCOR) model [8], [u32], or any other supply chain reference model. The same applies for the three value disciplines: three, four of even six. It is just a matter of choices. One note here: the larger the matrix, the longer it takes to analyze, but the more detailed the results shall be.

The analysis of the research framework is quite basic, due to a limited amount of time. The reader needs to be aware that it is not a complete overview of all possible collaborative solutions needed by manufacturing companies active in the Electronics industry, but only a rough impression. However, some interesting first conclusions and results are derived from the analysis, and presented in this report, but more detailed (survey or Delphi-style) research could be valuable here.

15.3.5 – Collaborative solutions

More detailed research is needed to further detail the collaborative processes as described in Chapter 7. Especially the *collaborative order fulfillment planning* concept may be an interesting candidate for further detailing. Questions to ask could be for example: Is the total visibility really needed? Or would a simple due date be good enough for planning purposes? Will companies really allow their partners so much visibility in their operations? Perhaps it would be good to start to discuss the need for visibility in relationship to types of information (such as due dates, rough schedules vs. detailed schedules, information on capacities, information of other engagements, etcetera) and flexibility of systems needed. Is a system that allows partner representatives – human or non-human – to discuss supply chain consequences in a distributed and concurrent way a solid step forward? How do negotiation mechanisms need to look like in detail?

Another interesting aspect would be the question how different collaborative initiatives influence one another. Recent Swedish research [101] draws the conclusion that it is likely that collaboration in one area stimulates collaboration in other areas.

15.3.6 – Industry perspective

The hypothesis that the Electronics industry structure will change over the coming years needs to be validated. The application of the concepts in this report to other industries, such as the automotive, aerospace & defense, and heavy equipment industries, could be studied.

15.4 – Further ICT related research

15.4.1 – Trading exchange infrastructure

Currently, the industry favors Private Trading Exchanges (PTXs) above their public counterparts; as 90% of investments in e-marketplaces flows to PTX initiatives [54]. As of today, 15% of Fortune 2000 companies has a PTX; another 28% plans to have one before the end of 2003.

A PTX seems to have some real advantages (as is shown in Chapter 9). A large advantage is that a PTX is not price focused, but process focused [54]. The prices might have been negotiated offline already; the PTX just functions as an information exchange. Furthermore it is invitation-only, and therefore it uses the strategic relationships that exist between partners and the company, and that have been built through years of effort by people in all parts of the organization. It becomes the tool for collaboration and enables all interaction with the (important) supply chain partners.

However, there are always (research) questions; such as: Is the PTX model really the model to prefer? Or are there situations where public marketplaces shall play a more important role? And in that case, what is the right business model for public trading exchanges? What kinds of functionality need to be part of PTX infrastructures? How do standards evolve, and how do they influence trading exchanges?

An important issue is whether companies need to build their own exchange, or join one from a partner. Hoffman et al. [54] show a model with two factors: (1) online interaction capabilities (technology, cultural and political), and (2) power within the supply chain. If both factors are high, it is recommended to build an own PTX. If the power is not that large, it would be better to join a partner's PTX. If this is true for the Electronics industry (and why wouldn't it be true?), the large EMS providers (such as Flextronics and Solectron) are recommended to build their own PTX's. The smaller and more specialized firms (such as for example Neways) could better join exchanges from important suppliers or customers. This could be an interesting domain for further research.

Interesting issue from a Baan company perspective, could be where, and how, to apply and position the Xebic Nucleaus platform [u39], [122]. Xebic's power lies in its modeling environment, which can be of good help in flexible environments with many different trading partners. Therefore, it could be interesting to partner with (established) public marketplaces that want to extend their service offering to its customers. That way they do not only provide more service, but also create a web of companies that might start to behave (through the technology support) as a virtual company.

15.4.2 – Proactive Resolution Broker concept

A recent Stanford University publication [73] introduces the so-called Supply Chain Performance Management (SCPM) concept. Surprisingly, it has a large similarity with the here-suggested Proactive Resolution Broker concept (see Chapter 10).

SCPM is a cycle consisting of identifying the problems, understanding the root causes, responding to problems with corrective actions, and continuously validating the data, processes and actions that are at stake. Although it has a large overlap with Supply Chain Event Management (SCEM) ideas, it moves beyond the SCEM functionality. SCEM, for example, overwhelms managers with a flurry of transaction-level details. It is also a learning system, which learns from actions from the past (in stead of simply monitoring for values as SCEM does). And diagnosis is an important part of the solution.

SCPM enables companies to identify exceptions, understand issues and alternatives, act on high impact problems and opportunities, and continuously validate actions relative to objectives and results. It is stated that the application area is not only supply chain related – but could be applied to other functional areas of an enterprise as well, such as product development, PLM, financial management, after-service support, sales and marketing, CRM, and even strategic planning.

More study is needed to understand the exact differences and parallels between SCPM and the Proactive Resolution Broker concept. It is absolutely an interesting area, and therefore more research (and pilot development) is strongly recommended.

15.4.3 – Agent technology

Traditionally, enterprise information systems are static information systems [60]; even SCEM systems. They accept a request, process this request, and deliver the answer. As such, there is a sequence: input, processing, output. In dynamic information systems – sometimes also referred to as adaptive planning systems [97] – those three phases are interwoven. The information is not just accessed once, but is continuously being monitored and appropriate actions are taken depending on particular signals detected in the data. The corresponding application infrastructure is frequently referred to as an agent based system.

Software agents [60] are small pieces of software with specific tasks, which continuously monitor the data sources in the computer network. When certain signals are detected in the data, the software takes the appropriate (corrective) action. Individual agents each handle very small and specialized tasks. Agents can make decisions themselves, or notify users of urgent events or problems. To coordinate and resolve conflicts between agents competing for the same resource, a superior coordination agent allocates the resources among the agents. This coordination agent is a mathematical model of the organization (and/or its objectives); an ontology.

Those more dynamic or adaptive enterprise information systems provide possibilities for real-time response to unplanned events. Furthermore, these tools could help to move beyond just exception handling to dynamically reallocate capacity based on different market factors (such as order profitability and future demand) and not just production constraints [97]. A good application area for agent technology could be the process of collaborative order fulfillment planning, as introduced in Section 7.4, or the Proactive Resolution Broker concept as introduced in Chapter 10.

Agent technology can, just like event management technology can, be used to optimize decision taking at the operational planning level. This is mainly due to the reduced cycle time in the decision making process, and therefore optimization is no longer restricted to the strategic and tactical planning horizons, but optimization can be performed in real-time.

Agent technology has no wide application currently, but it is a very interesting and promising area. Therefore vendors such as Vinimaya [u38] and Tryllian [u36] could better be monitored with care. The Open Buying on the Internet (OBI) Consortium [u26] plans to incorporate agent functionality as well.

Agent technology can mean a fundamental change for (collaborative) enterprise information systems. More research may be initiated.

15.4.4 – The enterprise software engines

Many state that ERP systems have matured, or even reached the end of their life cycles. However, this does not mean that no large improvements can be made anymore. This report already showed some major areas where improvements can be made, i.e. related to the external integration aspects. But also architectural issues such as the parameter problems as shown in Example 10.1 could be interesting areas for improvements.

Another interesting aspect – so far not covered – could be the different planning algorithms that are used for ERP and APS (Advanced Planning & Scheduling) planning. Recent new insights from Eindhoven University of Technology professor Ton de Kok [67] show that another (and simpler) planning approach (referred to as Synchronized Base-Stock control) could deliver (far) better results than the now used linear programming algorithms. An area that is absolutely interesting for further research – since it can easily improve the planning engine's performance; and be a major improvement for users (the companies) of these solutions.

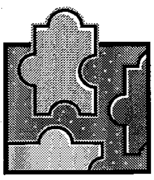
Therefore it remains worthwhile to continuously re-assess the software products, preferable also via joint research projects with universities (such as Eindhoven University of Technology), and remain critical towards own products and architectures.

15.4.5 – Multiple BOM issues

The article number and multiple Bill-of-Material (BOM) problems manufacturing companies in the Electronics industry have to face, deliver interesting challenges and opportunities. This report does some recommendations (see Section 13.5), but further research could be initiated and is highly recommended, since it is an area where large improvements can be realized.

15.5 – Future thoughts

Supply chain collaboration and all its problems, challenges, and opportunities is absolutely an issue that will stay the next years. Industries, inter-company structures, management principles, and the supporting enterprise information systems will change. Large opportunities, and a very interesting time are about to arrive. For research and business. Of course, nobody is capable to predict the future, but it may be stated that – so far – the world has not even seen the (small) top of the iceberg.



15.6 – Summary

Collaboration has been brought to the world as just another hype word. However, over the last year market predictions have been downsized, and the business world has become more realistic. Collaboration and tighter integration between supply chain partners definitely has a future, in all its aspects. It is recommended that the business (model) and enterprise information system development go hand-in-hand. No longer it is the software vendor who develops a product, a consultant who implements it, and the organization who just has to use it. Software vendors, consultancy firms and (large and important) customers need to close the lines, share their efforts and collaborate to develop tomorrow's collaborative (software) solutions.

Looking back, the choice for this subject has been a right one. The value discipline theory that was used, the Electronics industry, the role and position of EMS vendors herein, and collaboration, have caught the (research) attention from Academia recently. Companies that use ERP systems are the most likely to expand their systems towards partner connectivity, a first step towards collaborative environments. The report as such can be of use for companies in the Electronics industry, the academic community, enterprise software vendors, and consultancy firms.

Some suggestions are made for future research, divided in business model related research, and ICT related research. From a business model perspective, more research could be interesting to further detail the value discipline concepts, a fourth discipline referred to as network orchestration, the possible role of trusted third parties, the research model as such, and to detail the collaborative solutions. Furthermore it would be interesting to compare the Electronics industry with other industries. From an ICT perspective it would be interesting to expand the insight on trading exchange infrastructures, the proactive resolution broker concept, and the use of agent technology.

Appendix

Appendix

This appendix consists out of different chapters. It includes two reference lists, a list of abbreviations, and different appendixes, which provide useful extra information, but are not relevant enough to include in the normal report.

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Appendix 1 – Electronics Manufacturing Services

This appendix focuses on Electronics Manufacturing Services providers (EMS). It clarifies why Original Equipment Manufacturers (OEMs) outsource their production to EMS providers, gives an overview of the market size and the different market segments. Furthermore, the important EMS companies are introduced, and some recent changes in their everyday business are pointed out.

A1.1 – Reasons for OEMs to outsource

Figure A1.1 shows the findings of a 'Purchasing-magazine' survey [34], investigating the different reasons for OEMs to outsource their work to EMS companies. The survey was originally sent to 1,000 buyers in a variety of electronics industries including computer, communications, industrial controls, and medical equipment among others. The number of companies that were represented is unknown. The results were unweighted as the results were compiled based on the number of responses to each question.

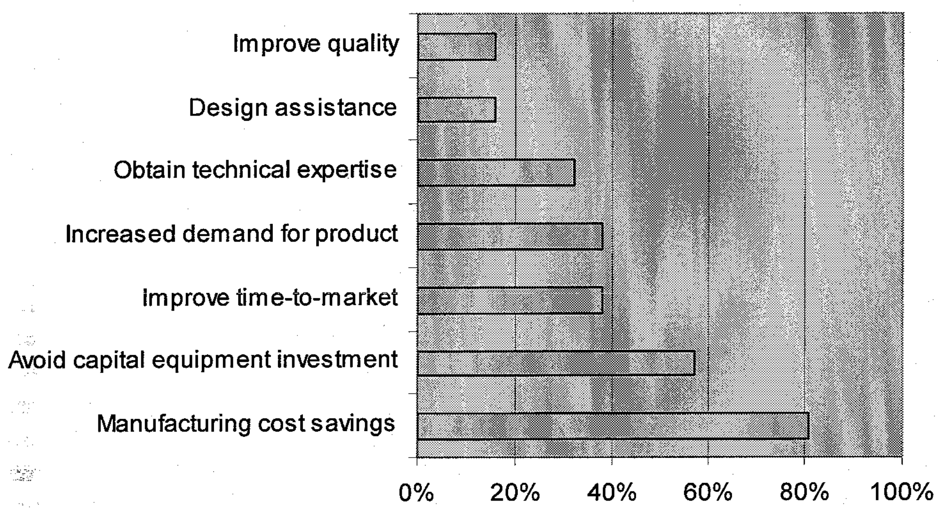

Figure A1.1 – The reasons for OEMs outsourcing to EMS providers

As this figure shows, cost savings seems to be the key motivator. Some other reasons for outsourcing may be [32], [33], [41]:

- New OEMs may never have had a core competence in manufacturing (especially for Internet and technology related companies).
- OEMs want to focus on two or three core competencies (such as Research and Development (R&D), end product design or customization, sales and marketing, service, and management of the supply network).
- EMS companies have international capabilities (what sometimes for example can result in lower tax rates) and purchase components at lower prices (due to aggregating demand, economies of scale, and concentrating more business with fewer suppliers).
- Manufacturing is too labor- and capital-intensive to support the high margins and fast growth that investors demand.

The 'Purchasing-magazine' research [34] furthermore shows that a majority of OEMs do not use more than five different EMS'. Although they plan to spend more with their current contract manufacturers over the next years, and rate the quality of their current contract manufacturers very high (97% rate them as good or excellent), they also think about giving business to contract manufacturers they currently do not use. Unfortunately, the survey does not show any detailed information on the number of EMSs used for a particular region or product group.

A1.2 - Industry overview

A1.2.1 - Market size

The contract manufacturing industry will grow less than 5% in 2001, according to market research firm Electronic Trend Publications (ETP, San Jose, CA), or dip into slight decline (-2%), as predicted by Technology Forecasters, Inc. (TFI, Alameda, CA). The compound annual growth rate is forecasted at about 20% over the next five years through 2005. Table A1.1 (source [5]), gives an overview of the (combined) predictions of ETP and TFI. Figure A1.2 illustrates the growth in market size over the coming years, adopted from this table.

Gartner Dataquest [110] expects a slight decrease for the year 2001, but still believes that the outsourcing market is counter-cyclical to the OEM business cycle. Just as ETP and TFI, they believe that the EMS companies will return to healthy growth in 2002 through 2004. During the late 90s the growth-rate of the EMS industry was three times higher than the growth-rate of the total Electronics industry [77].

According to the same forecasters there will be a decline in market share in North America (down from 58% to 53%) and Europe (down from 23% to 22%), and an increase in Asia (up from 17% to 23%). The rest of the world will remain unchanged at 2% in 2005.

However, it is always hard to figure out how good these predictions really are. Analysts and market research firms, such as Gartner, AMR, Forrester, ETP and TFI, are very flexible in their predictions. Nevertheless all signals lead in the same direction. The Electronics industry as such is expected to steadily grow over the coming years. Next to that contract manufacturers do continue to gain a larger part of the market since OEMs tend to outsource more of their production, year over year. Therefore it may be stated safely, that the market for EMS companies can be expected to show a large growth over the next couple of years.

Table A1.1 – Market growth predictions EMS market

Description	Estimated by	2000	2001	2002	2003	2004	2005
Worldwide EMS market (billions $)	ETP	103.2	107.9	129.9	163.9	204.2	249.7
	TFI	106.1	103.7	133.1	177.4	231.6	288.2
Calculated year-to-year growth (%)	ETP		4.6	20.4	26.2	24.5	22.3
	TFI		-2.3	28.4	33.3	30.6	24.4
Total available market (billions $)	ETP	705.3	650.1	692.8	749.7	802.5	862.9
	TFI	808.4	746.2	805.2	860.8	920.1	996.3
Calculated EMS penetration (%)	ETP	14.6	16.6	18.8	21.9	25.4	28.9
	TFI	13.1	13.9	16.5	20.6	25.2	28.9
Market estimates are from Electronic Trend Publications (ETP) and Technology Forecasters Inc. (TFI).							

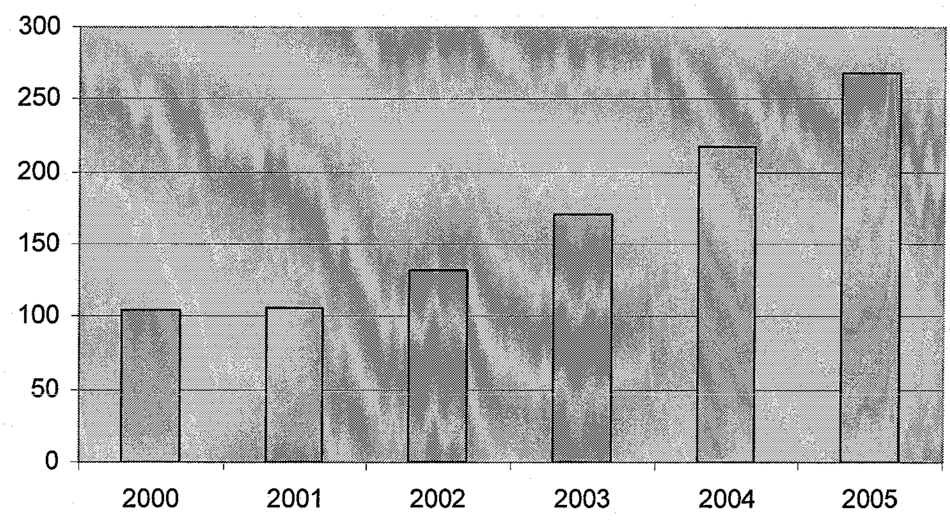

Figure A1.2 – Worldwide EMS market (billion $ US)

A1.2.2 - Market segments

Figure A1.3 (source: [5]) provides a graphical overview of the expected market shares for the different segments in 2005. Table A1.2 (source: [5]) shows the predicted values per market segment for 2005, compared with the values of the year 2000. The categories computer/office and communications – with products such as personal computers, PDA's, and mobile phones – represent by far the largest part of the manufacturing. The consumer segment that contains products such as televisions, audio equipment, and DVD players, is relatively small. It seems that OEMs still do a lot of the assembly and production for consumer electronics their selves.

EMS companies do also have OEMs from other industries than the Electronics. For the segments automotive, military/avionics, and industrial/medical, the EMS companies are mainly producing complex parts that will be used later on in the products manufactured by the different industries. Engine control systems for cars, flight navigation systems for the avionics, and monitoring systems for the medical world are some of the examples. A list with an overview of products per segment can be found in Table A1.3 (source: [4]).

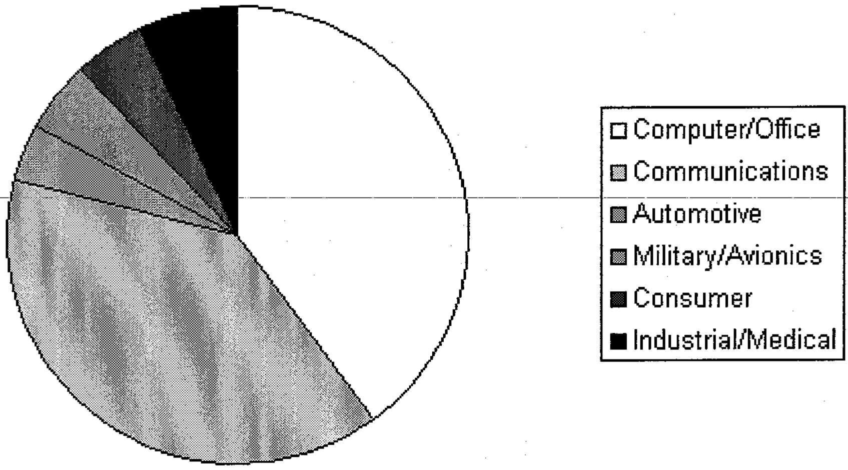

Figure A1.3 – Prediction market shares per segment for 2005

Table A1.2 – Prediction market shares per segment for 2005

Market segment EMS	Market share 2000 (%)	Market share 2005 (%)
Computer/Office	43%	40%
Communications	42%	39%
Automotive	1%	4%
Military/Avionics	2%	5%
Consumer	5%	5%
Industrial/Medical	7%	7%

Table A1.3 – Products in the different industry segments of the EMS market

Automotive	**Computer**	**Commercial/Office**
Engine Control	PC Motherboard & CPU	Copiers
Instruments	Server Motherboard & CPU	Fax Machines
Safety	WS Motherboard & CPU	Point-of-Sale Terminals
Entertainment	Hard Disk Drives	Calculators
	CD/DVD Drives	
Communications	Floppy Drives	**Military/Avionics**
LAN Switches	Monitors	In-Flight Entertainment
Routers	Printers	Flight Navigation
Hubs and NICs	Handhelds	Weapons
Modems		C3
Cellular Handsets	**Consumer**	Other
Other Phones	Analog TVs	
Wireless Data Equipment	Digital TVs	**Industrial**
Wireless Base Stations	Audio Systems	HVAC
PBX/Other CPE	Other Audio	Control/Processing
Carrier-Class Switches	Games	Test and Measurement
Other	Digital Set-Top Boxes	Other Industrial
	Camcorders	
	VCRs	**Medical**
	DVD Players	Medical Diagnostics
	Digital Cameras	Therapeutic
	Other	Monitoring and Surgical
		Other

A1.3 - EMS companies

A1.3.1 - Important players

Table A1.4 (source: [35]) provides an overview of the largest EMS companies. Not very important information from a research perspective, but nevertheless it does help to get a feeling for the market and the companies that play an important role in this market. Note that a 3- or 5-year growth rate would have been more insightful than a 1-year one as given here, but unfortunately these numbers turned out hard to find.

Be aware that Solectron, Flextronics, Elcoteq, MSL and Benchmark Electronics are important Baan customers.

Table A1.4 – Contract Manufacturing market overview

Rank	Company	Nasdaq symbol	2000 calendar year ($millions)	% change from previous year (1999)	Total employees	Baan customer
1	Solectron Corp.	SLR	$16,900	87.8%	60,000+	X
2	Flextronics International	FLEX	$11,200	134.1%	70,000	X
3	Celestica Inc.	CLS	$9,800	84.9%	15,000+	
4	SCI Systems Inc.	SCIS	$9,146	26.6%	34,000+	
5	Sanmina Corp.	SANM	$4,538	73.9%	24,000	
6	Jabil Circuit Inc.	JBL	$4,000	66.7%	19,115	
7	Synnex Information Technologies Inc.	SYXZF	$3,700	25.4%	1,600	
8	Elcoteq Network	ELCQF	$2,060	216.1%	11,371	X
9	Manufacturers' Services Ltd. (MSL)	MSV	$1,800	95.6%	7,000	X
10	Benchmark Electronics Inc.	BHE	$1,705	94.2%	5,500	X

A1.3.2 - Growth

EMS companies their selves grow through acquisitions or an expansion in their facilities and capacities. Growth through acquisitions can be realized by taking over another contract manufacturer, or by taking over the manufacturing plants and functions of OEM customers. It may be interesting to take a look at the Flextronics growth strategy, which is detailed in Example A1.1. Expected is that the number of competitors in this market will stabilize or even shrink, which means that the remaining companies on average get to handle more business; concentration is occurring.

Example A1.1 - The Flextronics' growth strategy

Flextronics [82], [u15] wants to continue to grow its business at a 30 percent yearly rate and 15 percent Return on Investments (ROI). One of the basic principles in their strategy is to do the majority of the work at low-cost locations, and to concentrate the low-volume, more-complex work in some of the higher cost-locations. For example, the capacity for Flextronics' manufacturing facilities in high-cost San Jose, CA has been cut about 50%, and there is no concrete foresight that this will ever increase again.

An important part of their vision [111], are their plans to streamline their manufacturing facilities into eight major manufacturing centers around the world. They currently have over 100 sites in 28 countries. Three of the manufacturing centers (Poland, Shanghai (China) and Dallas (US)) will be used to manufacture larger, complex and low-volume products such as communications infrastructure products. Three (Southern China, Malaysia and Hungary) will target high-volume consumer products. The remaining two locations, Guadalajara (Mexico) and Brazil, will be used for both types.

The Gartner Group concludes that this is a major change in the Flextronics vision. They are shifting from expansion to optimization. Integration of all the different parts will be the key; it won't be any longer that one does not know what the other is doing.

Flextronics does not seem to be the only one with a vision like this. Many EMS companies are redesigning their physical supply chain structure, rethinking their plant locations, plant sizes and business functions. This trend is driven by foreseen cost reductions made possible by economies of scale and a better integration of the different parts of the company.

A1.4 - Changing business

The structures in the Electronics industry supply chain network have changed over the last decades, as shown in Chapter 3. Relative simple contract manufacturers turned into real Electronics manufacturing services providers (EMS), and their offering of services has expanded beyond their original pallet of services.

Over the last years they have invested in the capabilities to offer the OEMs real 'soup to nuts' services [6], [33] including design, procurement, manufacturing, parts-assembly, testing, fulfillment and support.

EMS providers operate on low profit margins (average of about 3-5 percent), with approximately 80 percent of their cost of goods sold coming from materials [108]. By managing the cost of material, they can control their cost. However, this is difficult when OEMs are designing the product and controlling the approved vendor list or approved material list and simply direct EMS providers what to manufacture. Also, the OEM engineers often are unaware of design issues that could cause difficulties in manufacturing and could add to the cost. Collaboration between the design teams of OEM and EMS brings benefits like lower cost, and specific Design For Manufacturability (DFM). Next to that component manufacturers work with EMS companies to promote their products and share their technology road maps with the EMS design team. Some suppliers already have their people residing in the EMS' facilities [33].

Collaboration in the Electronics industry centers especially around the more strategic items, where a move can be seen towards more strategically long-term relationships with only a few suppliers [33]. On the other hand, the number of buy-relationships on an occasional basis rises, i.e. also due to new technology which makes it easy to buy on spot markets. The ideas as incorporated in the Kraljic purchasing matrix are a good explanation for these trends: equitable collaboration for strategic items, 'forced' collaboration for bottleneck and leverage items, and commodity buying for routine items. See [69], [70], [106] for more details.

The outsourcing trend from OEM to EMS continues, as is shown by the (expected) higher growth in box build – the building of entire systems for OEMs – as compared to printed circuit boards (PCB) assembly. Box build will account for 34% of all industry revenue by 2005, compared with 30% share in 2000.

Appendix 2 – Customer Order Decoupling Point

This appendix takes a look at the customer order decoupling point. Since decades, it is an essential element in modern logistics thinking. Therefore much has been published on this subject. This appendix lists some basics, with special attention for some of the problems caused by the make-to-stock typology. Supply chain collaboration is suggested as an instrument to overcome these problems. The last section describes recent insights how to handle supply networks.

A2.1 - Customer Order Decoupling Point

The Customer Order Decoupling Point (CODP) is the point from which the customer order penetrates into the control structures of the goods flow. Although some authors add more typologies, four typologies are generally recognized as different CODPs. APICS [u1] uses the following definitions: Engineer To Order (ETO), Make To Order (MTO), Assemble To Order (ATO), and Make To Stock (MTS). These typologies are shown in Figure A2.1.

Eindhoven University of Technology professor Hans C. Wortmann combined production typologies with production orientation (product, process or capability focused). His findings (or continuum) can be found in Table A2.1 (source: [69]). It serves as a good illustration to get a feeling for the different COPDs.

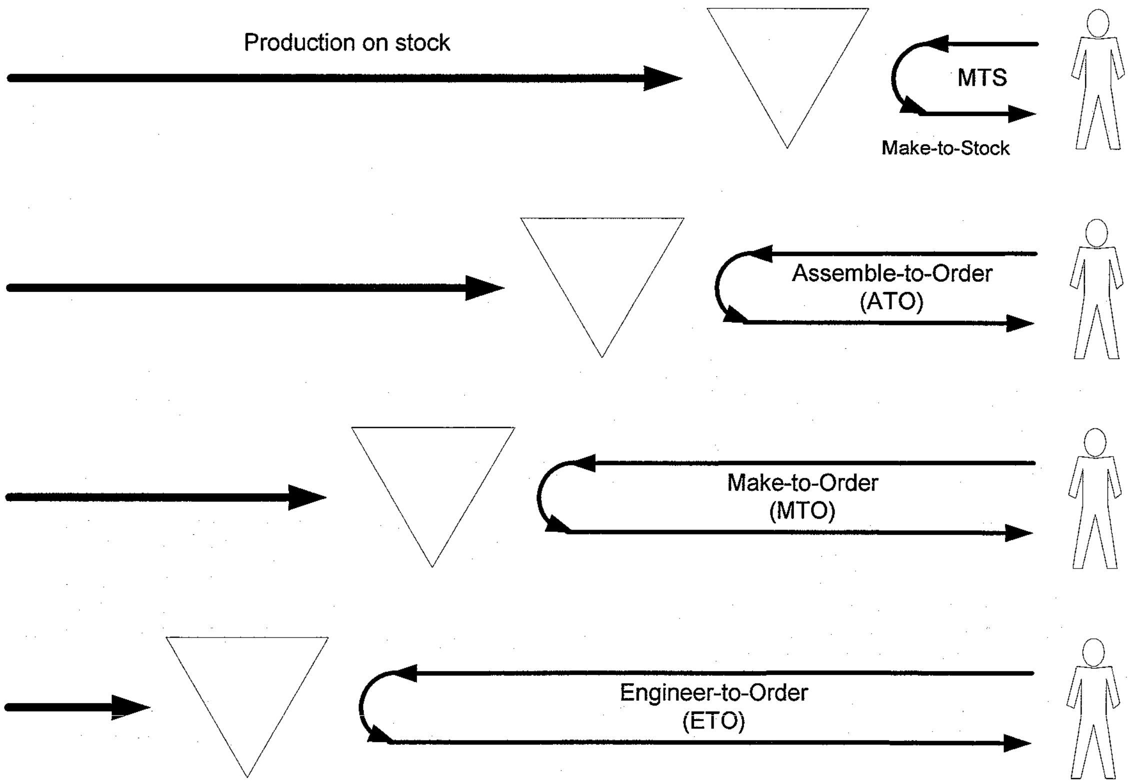

Figure A2.1 – Illustration of the customer order decoupling point

Table A2.1 – Production typologies versus production orientation

	ETO	**MTO**	**ATO**	**MTS**
Product oriented	Aircraft	Machine tools	Trucks	Commodities
Process oriented	Printing	Paper	Steel	Subcontractor
Capability oriented	Aerospace	Foundry	Construction	Repetitive manual assembly subcontractor

A2.2 - The destructive cycle of make-to-stock

Make-to-Stock (MTS) production environments face a destructive cycle [55], as Figure A2.2 illustrates. One aspect of a Make-to-Stock (MTS) policy is that sales are *push-based*. Goods produced needs to be sold, even when it does not exactly match the customer requirements. *Incentives and discounts* are instruments to enable this. As a result the margins on products fall down, what requests lower production costs. In a traditional situation the solution to handle this is by producing in *larger volumes*, to achieve economies of scale – so enforcing the MTS policy.

A second problem with MTS policies is that it might be possible to produce custom-build products, but that it *takes long* doing so (mainly because the custom product is competing for production resources). This works *discouraging* for customers, resulting in lower sales of custom-build products in the nearby future. A negative result of this is that the *gap to market demand information* will grow.

Both cycles result in more sales from stock, and a larger disconnection from real customer demand. The company relies more on its forecast, and loses sight of real customer requirements. In case a custom order does come along, it is even harder to handle it sufficiently. As this gap grows, the less likely it becomes that the forecast will match real customer requirements.

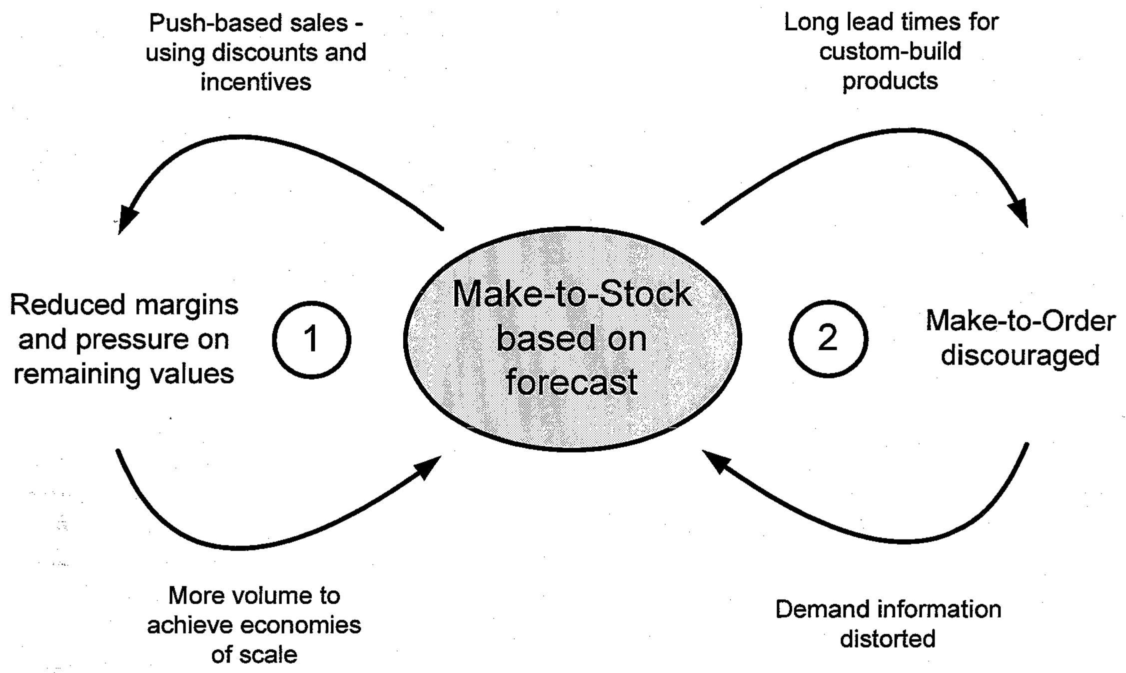

Figure A2.2 – Destructive cycle of Build-to-Stock policies

Collaboration with supply chain partners (i.e. collaborative planning initiatives) is one of the key elements for implementing a successful Make-to-Order (MTO) typology, since it helps to reduce the bullwhip effect [88]. Collaborative planning tackles the basis of the destructive cycle just mentioned. Demand information is less distorted, and therefore its quality is better. The sales system can make a fundamental change towards a pull-based system. The disadvantages of the push-based system, such as the reduced margins, can be overcome.

MTO works especially well in relatively simple environments – like the Electronics industry – with products that have few components but many variants. A frequent use of the same components will likely translate into stable demand in the supply chain.

A2.3 – Consumer Order Decoupling Point

The CODP theory was developed for individual enterprises, and not for networks of interconnected enterprises. Recent work (see for example [67], [118]) suggests that networks should move beyond traditional local optimization; and move the inventory towards the Consumer Order Decoupling Point (CODP-II ???) – the CODP that faces the end customer, or consumer. The CODP-II is the only CODP where customer service really matters. The CODP-II is the weakest link, and responsible for the performance of the network. Stock in networks, therefore, can better be moved to the end of the chain. The local CODP's up in the chain therefore will see a reduction in inventory.

Appendix 3 – Zone of indifference

This appendix gives a short introduction to the 'zone of indifference' concept as has been introduced by consultancy firm McKinsey.

A3.1 – The theory

'The zone of indifference' theory [66] (see Figure A3.1) explains that there is an *indifferent zone* between the upper level of the degree of satisfaction "*dissatisfied*" – the first dashed line in the figure – and the lower level of "*very satisfied*" – the second dashed line in the figure. Moving positions within the zone of indifference does not make too much sense, because the customer does not recognize the added value. The customer first recognizes the extra value when a company moves into the area "*very satisfied*". It seems logical that the three aspects related to the different value disciplines (i.e. best costs, best product and best total solution) all have their own zone of indifference. Customers only recognize the real market leaders, related to best cost, best product, or best total solution, if they excel outside this zone of indifference. As a result, concentrating the focus on one of the disciplines, instead of taking baby-steps in all the disciplines, might prove more sensible since it moves a company outside the zone of indifference, and thus provides more added value to customers. Note that industry standards are inclined to rise every year, due to rising customer expectations, so companies need to keep on improving continuously at all fronts.

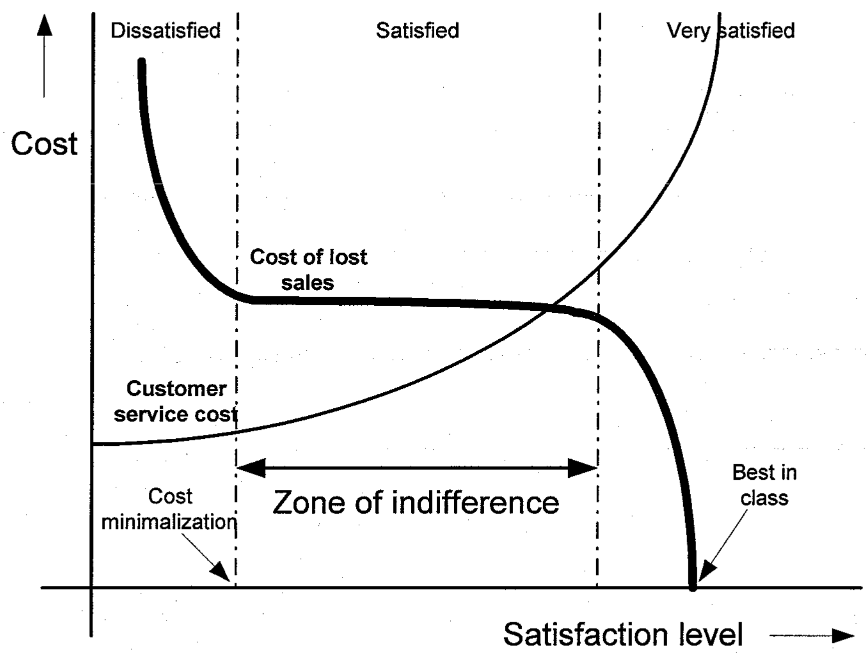

Figure A3.1 - The 'zone of indifference' concept.

Appendix 4 – Profit margins Electronics industry

In this appendix the profit margins of companies active in the Electronics industry are focal point. The margins have been collected for the period 1998-2001; since that may give a better insight in the actual status than the numbers for one single year.

A4.1 – Profit margings

Table A4.1 gives an overview of some of the profit margins of companies active in the Electronics industry. The percentages in this table are all derived from the same source: nasdaq.com [u21], to avoid different ways of calculating the same numbers. All companies listed in this table are, at least to a certain extent, involved in the Electronics industry. The only exception is Microsoft – that company is active in the Electronics industry in its role as an OEM (Original Equipment Manufacturer) in computer hardware (mice, gameconsoles, etc.); but the largest part of the firm is devoted to the software industry. Nevertheless it is listed here.

Table A4.1 – Profit margins in the Electronics industry

Company name	Stock symbol	1998	1999	2000	2001	3 or 4 year average
Solectron Corp.	SLR	N/A	3.62%	3.52%	-0.66%	2.16%
Flextronics International	FLEX	1.29%	2.28%	-3.68%	-1.17%	-0.43%
Celestica Inc.	CLS	-1.49%	1.29%	2.12%	-0.40%	0.51%
Sanmina Corp.	SANM	N/A	4.00%	4.96%	1.00%	3.32%
Jabil Circuit Inc.	JBL	N/A	3.79%	4.09%	2.74%	3.54%
Manufacturers' Services Ltd. (MSL)	MSV	-0.75%	0.22%	-0.23%	-6.25%	-2.34%
Benchmark Electronics Inc.	BHE	3.12%	1.36%	1.17%	-4.25%	0.47%
Compaq	CPQ	N/A	1.48%	1.34%	-2.34%	0.16%
Sony	SNE	2.63%	1.82%	0.23%	0.20%	1.63%
Hewlett Packard	HWP	N/A	8.24%	7.57%	0.90%	5.57%
Dell	DELL	8.00%	6.59%	6.83%	4.00%	8.47%
Apple	AAPL	N/A	9.80%	9.85%	-0.47%	6.39%
Motorola	MOT	-2.89%	2.69%	3.51%	-13.13%	-3.27%
Nokia	NOK	13.13%	13.03%	12.96%	7.05%	15.39%
Cisco	CSCO	N/A	16.62%	14.41%	-4.55%	8.83%
Corning	GLW	11.31%	10.88%	5.92%	-87.66%	-19.85%
Texas Instruments	TXN	5.09%	14.87%	25.75%	-2.45%	14.42%
Xilinx	XLNX	15.50%	63.90%	2.12%	-11.19%	23.44%
SanDisk	SNDK	11.47%	12.90%	56.74%	-94.03%	-4.31%
Intel	INTC	23.10%	24.89%	31.24%	4.87%	28.03%
Advanced Micro Devices	AMD	-4.09%	-3.11%	21.17%	-1.56%	4.14%
IBM	IBM	7.75%	8.81%	9.16%	8.99%	11.57%
Nortel	NT	-7.61%	-1.65%	-11.46%	-155.91%	-58.88%
Microsoft	MSFT	39.42%	41.04%	29.04%	27.60%	45.70%

A4.2 – Analysis

This table makes clear that the large Electronics Manufacturing Services providers (EMS's) (SLR, FLEX, CLS, SANM, JBL, MSV, and BHE) have profit margins varying (calculated for a three years average) between a small loss (-2.34% for MSV) and a small profit (3.54% for JBL). This demonstrates that these EMS's are operational excellent companies, not facing end consumers, with margins representative for purely cost-focused competition.

Although the numbers for the other companies vary widely, it might be concluded that a product leadership or customer intimacy strategy can lead to higher profit margins. Good examples are Nokia, Intel and Cisco. The number of companies listed is to short to draw real conclusions from these numbers, but nevertheless it gives a good feeling for the different positions within the chain. A separate study is needed to test these hypotheses, but that does go beyond the scope of this research project.

Appendix 5 – Item numbers and multiple BOMs

This appendix describes the specific problems companies in the Electronics industry have related to item numbering and multiple Bill-of-Materials (BOMs).

A5.1 – Component problems

Manufacturing (or assembling) companies in the Electronics industry – i.e. the Electronics Manufacturing Services (EMS) providers, and Original Equipment Manufacturers (OEMs) – face two problems/challenges that relate to the use of components.

First, there are many minimal differences between the (physical) characteristics of (in theory) alternative components, therewith turning these components in non-alternatives. Examples are components (such as chips) that have been assembled by other suppliers, in other plants (of the same supplier), or do come from another (updated) series; all carrying slightly different (e.g. electrical) characteristics. These differences in the characteristics can be in the way the material can be utilized and handled, and the way it is assembled, but also in the physical sizes of the component.

The designs of products in the Electronics industry are generally cutting edge, and do rely heavily on exact specifications of the separate components. To make it more complex; separate components do influence other components' functioning. Companies cannot take the risk to replace individual components by an alternative without thoroughly testing all influences.

Combining this with the short product-lifecycles and the ongoing introduction of modifications for existing products and components, it will be clear that this results in an article-numbering problem.

Second, often the same end product can be build through different Bill-of-Materials (BOMs). That could be a difference in the use of one single component, but could also mean that the BOM does really differ and single components are not simply interchanged with an alternative, but the whole BOM has another layout.

Note that these issues are not unique for the Electronics industry. Other industries (such as for example the Animal Feed industry) have comparative challenges to manage and control.

A5.2 – An example

A concrete example of one of these problems is illustrated in Figure A5.1. In this example four different options exist for the requested component, a 256 MB chip. The question becomes more complex when all kind of rules will be applied. Production needs to start at a given time, price is preferably as low as possible, a chip of type II is preferred, and the relation with vendor A is much better than the one with vendor B, etcetera. Next to that the chip from option two might probably cause a conflict with another component that will be used, due to the thermal conductivity properties. Option four is cheaper, but its dimensions are larger, so resulting in more expensive parts somewhere else in the product that will be putted together.

Normally this kind of decisions are made in the design phase, but in a market where components become obsolete fast, and where prices are highly variable, as is the availability of components, decisions like this (need to) become part of the normal business. Companies that are good in controlling these processes can safe a lot of money (and time), and that translates directly to the bottom line.

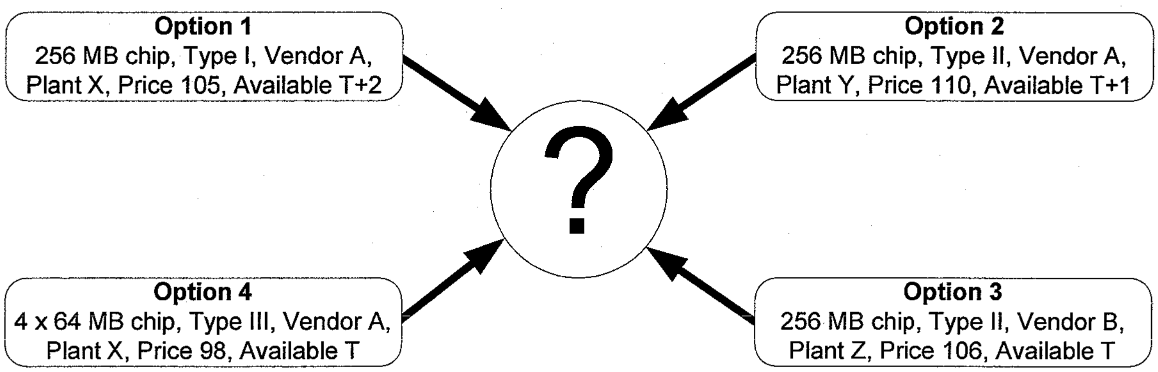

Figure A5.1 – Illustration of a component selection problem

Appendix 6 – Collaborative solutions

This appendix describes the analysis performed to identify collaborative processes. The idea is lined out, the definitions can be seen, and the matrix is shown.

A6.1 – The idea

To analyze the needs for collaborative solutions the following approach has been followed: combine business functions with value disciplines (in a matrix), analyze this – with the background information which is present already, and input from experts and companies – and envision interesting collaborative process areas.

A6.2 – Definitions

The following definitions have been used for the different business functions as adopted from the Supply Chain Management model form Chapter 2.

Marketing:	The process of capturing the market requirements and introducing products to the market
Research & Development:	The process of discovering new knowledge about products, processes, and services, and then applying that knowledge to create new and improved products that fills market needs.
Forecasting:	The process of estimating future sales levels by examining and analyzing available information.
Procurement:	The process of selecting and buying products.
Production:	The process of (planning and) producing products.
Logistics:	The process of managing the movement and storage of products through the supply chain.
Sales:	The process of selling products and resulting in the production planning.
Customer Service:	The process of managing customer education, customer complaints, and field services and support.
Finance:	The process of managing the financial flows, and analyzing financial business performance information.

A6.3 – The matrix

Table A6.1 shows the complete matrix with the end-results of the analysis. The matrix is filled with answers to questions, such as:

- What is the function of this block in the matrix? For example: What does that mean 'collaborative sales' under an 'operational excellence' strategy?',
- Relevant? Yes or no? And how relevant (on a scale – directly showing the important blocks, that can work as a priority list).
- What are the business drivers that request this solution? Translate into ROI and costs.

All the areas have been rated on a certain scale, where 1 means a high priority, and 5 means no priority. The areas that have a score of 1 or 2 can easily be recognized, since the areas have been colored gray.

Table A6.1 – Focus points for collaboration

		Product leadership		Operational excellence		Customer intimacy
Marketing	2	Marketing information and the different processes need to be collaborative. To translate innovative ideas into successful product introductions.	5	Although a strong market focus is needed, and the trade of lost sales/obsolescence is important, this is not a process to collaborate upon for EMS companies and their partners. Leave this to the OEM.	4	A market segmentation view is needed, but marketing is not really an issue to collaborate upon with SC partners.
Research & Development	1	To get products fast to the market collaborative design, and collaborative fundamental research is needed to get innovative products to market asap.	2	Collaboration in the design phase is important to fit design with manufacturability and testability (DFM, DFT). All is focused to bring down production costs.	5	Customer focused products are needed, but design and R&D is not an issue for EMS' to collaborate upon. Leave this to the OEM.
Forecasting	3	The trade-off between lost sales/obsolescence is important. Manage the forecast through the chain.	2	Trade off lost sales/obsolescence and the use of common components under a MTO policy ask for collaborative forecasting	2	The customer is important. To serve them well, good forecasting is essential. Involve supply chain partners for best results.
Procurement	4	Do not take risks in procurement domain. Use dedicated partners.	1	Low cost transactions. Low price focus. Commodities buying.	2	Service orientation. Customizability & flexibility of goods is essential.
Production	4	Planning and order status are not essential for product leaders.	1	A good planning of the operations drives the business. Sharing of production visibility information is very important – as are alerts when things go wrong.	3	Visibility information and alert handling though the chain is important.
Logistics	3	Logistics is important when related to time-to-market issues, but while network design is not that complex it is not a real issue.	2	Managing the logistics network decisions can be a cost saver.	3	Important, with a focus on the customer life cycle. Closely related to the collaborative sales process.
Sales	4	Sales is important, but not something to do collaborative. Network is not complex, and cost savings are no primary driver.	2	Collaborative sales processes can help to take optimal network design decisions and can help reduce costs.	1	The customer has impact on the network design. It can help to serve customers exactly the way the company wants.
Customer Service	4	The primary role here is for the OEM. Data need to be shared with them.	5	There is no role for a cost focusing EMS in customer service	1	Serving the customer the way he deserves is key. EMS can take a lead here.
Finance	4	Operational financial processes are not collaborative. Share the benefits and performance information (from a chain perspective). Review network design frequently.	3	Cost focus is important. Share the benefits and performance information (with chain partners).	5	Share the benefits and performance information (with chain partners).
Main issues:		A. Innovative products to market as soon as possible. B. Supply chain design based on foresights and vision, revision frequently.		A. Cost effective operational fulfillment network planning. B. Cost saving by an optimal design.		A. Customer focus drives sales process and network planning B. Customer service management is important.

High priority <- 1 2 3 4 5 -> No priority

A6.4 – Clustering hotspots

Looking at the matrix as such, it can be easily seen that different areas interrelate. Sales and service, for example, are areas that are related, there can be no doubt about. Therefore it may be best to design the process for such functions also from a shared perspective.

The following collaborative processes have been clustered from the separate areas which are interesting:

1. Collaborative design for innovative products -> PL (Marketing, and R&D)
2. Collaborative design for optimal production -> OE (R&D)
3. Collaborative planning & visibility -> OE and CI (Forecasting and Procurement)
4. Collaborative order fulfillment planning -> OE and CI (Procurement, Production, Logistics, and Sales)
5. Collaborative customer service -> CI (Sales, and Customer Service).

The 'collaborative order fulfillment planning' concept so combines 4 different domains. However, all the decisions to take for these domains do definitely interrelate, and therefore it may be better to combine everything in one smart process. If this works in practice is another discussion. However, it is one of the suggestions in this report.

List of Abbreviations

3PL	Third Party Logistics
APS	Advanced Planning (& Scheduling) Systems
ATP	Available To Promise
B2B	Business To Business
BI	Business Intelligence
BOB	Best Of Breed
BOM	Bill Of Material
CEM	Contract Electronics Manufacturers
CODP	Customer Order Decoupling Point
CODP-II	Consumer Order Decoupling Point
CRM	Customer Relationship Management
CTP	Capable To Promise
DEM	Dynamic Enterprise Modeling
DFM	Design For Manufacturing
DFT	Design For Testing
EAI	Enterprise Application Integration
ECR	Efficient Consumer Response
EDI	Electronic Data Interchange
EMS	Electronics Manufacturing Services
ERP	Enterprise Resource Planning
ETO	Engineer To Order
ICT	Information and Communication Technology
KPI	Key Performance Indicator
MRO	Maintenance, Repair and Operating (goods)
MRP	Material Requirements Planning
MRP-II	Manufacturing Resource Planning
MTO	Make To Order
MTS	Make To Stock
NPI	New Product Introduction
OBI	Open Buying on the Internet
ODM	Original Design Manufacturers
OEM	Original Equipment Manufacturers
PCB	Printed Circuit Boards
PIP	Partner Interface Process (RosettaNet)
PLM	Product Lifecycle Management
PTX	Private Trading Exchange
R&D	Research and Development
RFQ	Request For Quotation
ROI	Return On Investment
SCEM	Supply Chain Event Management
SCM	Supply Chain Management
SCOR	Supply Chain Operations Reference (model)
SCPM	Supply Chain Performance Management
SRM	Supplier Relationship Management
UCC	Uniform Code Council
UNSPSC	United Nations Standard Products and Services Classification
VMI	Vendor Managed Inventory
WFM	Workflow Management
XML	Extended Markup Language
XRL	Exchangeable Routing Language