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Information Technology for Purchasing

How to Use the Power of Information Technology in Present-Day Purchasing

Rob H.A. van Stekelenborg

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INFORMATION TECHNOLOGY FOR PURCHASING

PROEFSCHRIFT

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prof.dr.ir. J.C. Wortmann

en

prof.dr. A.J. van Weele

Preface

Although the strategic profile of purchasing in industry has mostly been acknowledged by now, it seems as if purchasing's 'tool box' has not been aligned to this new role yet. This study thereby focuses on the use of tools based on information technology (IT). From the beginning of the adoption of IT in business, purchasing has been perceived to lag behind in reaping the fruits that present-day IT tools can provide.

This study provides purchasing professionals with a comprehensive entry into the field of IT for industrial purchasing. It answers questions about the current state of affairs in applying IT in purchasing and the reasons for this situation, and it provides design directives that can serve as a guide in deciding how IT can deployed to effectively support the contemporary purchasing function. In this way this study supports the effective and efficient development and selection of information systems for the industrial purchasing function.

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Conference in Eindhoven. The contribution of Luitzen de Boer (Twente University) to the work on source selection is also greatly acknowledged.

In addition, I want to express my gratitude towards the Dutch Association of Purchasing Management (the NEVI) for sponsoring the research. In this respect I want to thank Evert-Jan Bosman for his support and Dr. Piet Beekenkamp — NEVI representative in the steering committee of the research — for his contributions to the research. I also want to thank the Supply Chain Management group of KPMG Management Consulting for sponsoring the final phases of the project.

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Last but certainly not least, I want to thank my parents for the almost infinite support and confidence they gave me throughout the years, and my girlfriend Monique for her patience with me being mentally absent so often during the last months of writing.

Rob H.A. van Stekelenborg
Eindhoven, the Netherlands
June, 1997

About the Author

Rob H.A. van Stekelenborg (1967) completed his secondary schooling (Atheneum-B) at the Van der Puttlyceum in Eindhoven. He then continued his studies at the Eindhoven University of Technology. After a year of studying Electrical Engineering, he switched to continue his studies at the faculty of Industrial Engineering and Management Science. In March of 1992, he received his M.Eng. degree in Industrial Engineering and Management Science, with a major in Information Management. During his graduation assignment he worked for Fokker Aircraft in the field of Engineering Data Management.

Upon graduation he worked on a research project at the Eindhoven University of Technology concerning the use of information technology in industrial purchasing, of which this dissertation is the result. This project was carried out under supervision of prof. dr. ir. J.C. Wortmann and prof. dr. A.J. van Weele. Within this context he worked on several projects in the Dutch industry (at Akzo-Nobel, ASM Lithography, DAF Trucks, Fokker Aircraft, Philips Electronics, and Royal Dutch/Shell) and published several (international) articles. He also worked together with B*aa*N, a Dutch ERP software vendor. The research project was sponsored by the Dutch Association of Purchasing Management (NEVI).

Rob H.A. van Stekelenborg is currently employed as a consultant in the Supply Chain Management Group of KPMG Management Consulting in the Netherlands. There he is involved in the development and implementation of solutions in the fields of sourcing, supply base management and supply chain logistics in industry. Within this framework his is also active in KPMG's global network on World Class Purchasing.

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Summary

Although purchasing has undergone significant changes, this has not been reflected in the tools used to support purchasing

As business strategy has been moving away from in-house manufacturing towards an ever increasing dependence on suppliers and subcontractors it is not uncommon that a significant share of a company's annual sales turnover is related to purchasing. Because of the increasing importance of purchasing, purchasing managers are confronted with questions concerning the justification of their decisions and the resulting performance. At the same time, purchasing decisions are of an increasingly complex and unclear nature due to the involved strategic aspects. As a result, purchasing has undergone significant changes over the last few decades which is, e.g., reflected in the educational levels of purchasing personnel. The same could be expected from the use of information technology (IT) in purchasing. The opposite is, however, often reported. From the start of the computerization of business, purchasing has been perceived to lag behind other organizational functions as marketing, product development, and logistics in its assimilation to IT.

This design-oriented study therefore investigated how IT could be used effectively in supporting contemporary purchasing practices

The challenge of this research was to increase the existing knowledge on the effective use of IT in contemporary industrial purchasing. The main research question therefore was stated as *what IT functionality should and can be applied to effectively support contemporary industrial purchasing*. This study therefore answers questions about the current state of affairs and why there seems to be so little progress. Furthermore, this study provides design principles, directives and reference models that can serve as a guide in how to support purchasing with information technology.

To answer the research questions the design-oriented study was subdivided in three phases, viz., (1) preliminary research, (2) analysis, and (3) design. The first preliminary phase involved desk research and four case studies. In the analysis phase insight was gained through an extensive and thorough desk research, and through the study and evaluation of software

packages and existing reference models. In the design phase, case studies took place to detail the existing knowledge on purchasing tasks, processes and situations. This led to the definition of five design principles that were evaluated in two subsequent case studies and workshops, and used in a project aimed at the improvement of an actual software package.

IT has almost fully penetrated purchasing, but its support is still limited

It showed that over the last three decades IT has almost fully penetrated purchasing departments in industry. The use of IT over the last 25 years thereby evolved from automating the clerical and administrative chores of the buyer (in the sixties), to management reporting and integration with production planning (in the seventies), to decision support and communication (during the eighties). The nineties, finally, showed the emergence of many new technologies, the application of which is only at the beginning. Although many advanced applications were reported in the literature, the typical use of IT in industrial practice is mostly limited to the application of standard ERP packages. These mainly address the repetitive purchasing of simple, standard and encoded items that are required in the production or assembly operations. The procurement of complex products attended with ample specifications is less well supported. Functionality to purchase order specific items is not always available or only limited. Outsourcing is mostly considered a stepchild and is not very well supported. The reference models that were studied differed in their level of detail, but showed a similar coverage as the software packages as they primarily addressed operational and administrative purchasing activities in production environments. Some models thereby focused on requirements stemming from MRP or stock replenishments, others focused on individual requisitions. Less typical was the presence of customer order specific purchasing, multi site purchasing, quotations, complex supplier structures, item classes, and a separate purchasing BOM.

Reasons for this state of affairs were found to be the efficiency focus in applying IT, the difficulties in demonstrating purchasing's added value, the unstructuredness of parts of the purchasing process, and a lack of mutual understanding between purchasing and IT professionals.

IT should be more supportive to initial purchasing in new task and modified rebuy situations

Following the first conclusions, the next part of the research focused on the new directions in which supportive IT systems in purchasing should evolve. The conclusion was that any new applications should be more supportive to so called initial purchasing tasks (i.e., sourcing, outsourcing, product design and demand planning) in new task and modified rebuy situations, and the subsequent evaluation of the effectiveness of the decisions taken in these tasks (i.e., performance measurement and assessment). As we found an increased presence of performance measurement systems in industry we focused our efforts on the application of IT in initial purchasing. The characteristics of this application area called for (1) analyses, evaluation and simulation tools; (2) flexible reporting and query capabilities; (3) communication functionality; (4) resource and process management tools; and (5) extended data and document management functionality.

Initial purchasing contains three main tasks, viz., (1) sourcing, (2) representing supply aspects in outsourcing, product design, and demand planning tasks, and (3) purchasing management

Initial purchasing tasks could be subdivided into purchasing and purchasing management tasks. Purchasing tasks involved sourcing (including the definition of sourcing policies, selection, qualification and contracting activities) and representing supply aspects in outsourcing, product design and demand planning activities. As there are many different and successive events that can trigger the purchasing process, in practice there are often many purchasing processes running simultaneously. Furthermore, initial purchasing processes are often of a complex and lengthy nature. Therefore, these processes in itself are subject to managerial activities referred to as purchasing management tasks. Purchasing management tasks involve the establishment of purchasing policies, (multi-)project management, and operational management of purchasing activities.

Purchasing carries out its tasks in many different ways, primarily because of differences in the uncertainties and significance of a particular case

There are many different modes in which purchasing carries out the tasks identified above, as there are many different situations and cases that purchasing has to deal with in initial purchasing. The purchasing process thereby primarily focuses on dealing with purchasing risk, whereby purchasing risk can be defined by the uncertainties and significance of the case. Both during initial purchasing and after initiating supply, activities aim at reducing uncertainties through the collection of data. Initially, these uncertainties can pertain to demand and supply, and to issues relevant for quality, delivery and costs. The strategy in dealing with these uncertainties thereby depends not only on the source and subject of uncertainty, but also on the consequences that are related to possible non compliance with specific requirements. These possible consequences are indications of the significance of the case. Furthermore, the role of information and communication turned out to be essential in dealing with uncertainty.

Five design principles for designing IT based tools supportive to initial purchasing and its management were proposed

The implications of the foregoing analyses gave rise to the definition of five design principles addressing (1) the found differences in initial purchasing and purchasing management tasks, (2) the move towards more extensive purchasing practices, (3) the found differences in the familiarity with cases, (4) the diversity of cases that was encountered, and (5) the variability of the approach taken to handle a case, even during the execution of the purchasing process. The five design principles that were subsequently proposed were:

1. **Distinguish between support for purchasing and purchasing management.** IT functionality should be grouped into toolkits according to purchasing and purchasing management tasks. Systems for purchasing management should accommodate data on processes, resources, documents, operations and tools. As many generic tools are already available for these managerial tasks, use should be made of existing tools as much as possible, implying the need for (re-)structuring and modeling purchasing practices. Systems for specific purchasing tasks should accommodate data on supply (sources, contractual relations, activities and products).
2. **Provide extensive support for the new business environment.** Systems should accommodate extensive supply models to meet the requirements of phenomena like suppliers as network partners, early involvement, and capability based decisions.
3. **In familiar cases, enable the use of reference data.** If possible (based upon the familiarity with the content of the case to be handled, as well as the approach to deal with the case), systems should provide reference data on the content of the case, and/or on the approach to deal with the case.
4. **Provide generic support for a large diversity of cases.** If a system should be able to accommodate a wide diversity of cases (like supplier profiles, purchasing procedures, purchasing documents, etc.), use should be made of generic object models as it allows many variants to be documented.
5. **Provide adaptable support for variable purchasing processes.** If a purchasing system needs to be adaptable to support processes that

involve many initial uncertainties, again, use of generic object models is useful as it enables flexible definition of descriptive features.

In setting up an IT based environment to support purchasing, the architecture should distinguish between a managerial layer, a purchasing specific layer, a document management interface layer, and an ubiquitous communication toolkit.

The five design principles proved to be useful, feasible and beneficial, however, issues of integration and pre-implementation efforts remain
After defining the design principles, they were evaluated through the development of two prototypes, which also allowed for the inclusion of detailed extensions and the identification of remaining issues.

The first case study aimed at the development of a prototype for source selection activities. The initial need survey that was carried out illustrated the importance of flexibility in any supportive tool, which pointed out the need for a tool that could support the diversity of cases, and that accommodated an adaptable data base. Furthermore, important aspects of a supportive system concerned the possibility to monitor possible events that might trigger the sourcing process, to accommodate extensive supplier and supply network data on various levels of abstraction (Design Principle 2), to provide generic support for checklists (Design Principles 4 and 5), to provide support for access and requests for data, and to use the generic concept for generating case specific procedures for source selection (Design principle 4). The subsequent evaluation of the prototype showed that integration with and access to other systems, and data distribution were important aspects in actual implementation. Furthermore, it was felt that the added value of the perceived system was in providing access to significant data in the source selection process, and the impetus that was expected from such a system on the consistency, structure and transparency of the process itself.

The second prototype aimed at providing support for contracting activities in purchasing. Documents play a very important role in contracting. A distinction can thereby be made between (state independent) standard contracts and (state dependent) specific contracts which is addressed by Design Principle 3. Other important aspects of these documents were related to the use of structured data elements or so called 'dotted line' elements, the fact that contracts are mostly of a similar structure, and the fact that many of the texts are reused in different documents. These issued could be addressed by adopting the generic object model for documents (Design

Principle 4). Furthermore, document management functionality was incorporated. In the evaluation of the prototype it was found that the possibility of accommodating contracting knowledge (and subsequently configuring specific contracts based upon this knowledge) was perceived as being the major advantage of the proposed system. To harvest these benefits, however, considerable pre-implementation efforts were thought to be required in restructuring documents and processes, and in discovering and representing applicability rules. Furthermore, it was clear that the integration with systems, particularly those that accommodate the structured data used in the documents, would require additional attention.

Further research into purchasing and information technology

Further research initiatives that were identified at the end of this study were categorized into research in the field of purchasing, the use of IT in purchasing, and IT itself.

First, in the field of purchasing, research efforts could be aimed at further clarifying and detailing purchasing's specific tasks in outsourcing, product design and demand planning tasks. As we argued that purchasing has to represent supply aspects in these activities, the role of suppliers itself in these activities might also prove an interesting topic to study. Next, the findings concerning the nature of purchasing processes might provide a starting point in studying the way in which (re-)organizing or re-engineering purchasing processes and their management can be used to achieve performance improvements in purchasing.

Second, in the field of purchasing and IT, as no thorough evaluation of costs and benefits of IT in purchasing has been provided in this study, research may provide additional and detailed insight into the cost effectiveness of the use of IT in purchasing. Also, the distributed nature of purchasing operations requires further attention from an IT point of view. Furthermore, new developments such as the Internet and the procurement card provide ample possibilities to research.

Finally, in the field of IT, it is recommendable to further study the use of the extremely powerful concept of generic object models. This also implies that the expliciting and management of domain knowledge will become increasingly important in business, which might provide many research opportunities. On the other hand, the use of this concept also introduced new issues concerning integration of IT based systems which may be studied. Especially the role of application independent documents may prove fruitful in this type of research.

Samenvatting

Ondanks het feit dat inkoop in de laatste jaren significante veranderingen heeft doorgemaakt wordt dit niet gereflecteerd in de ondersteunende informatiesystemen

Sinds ondernemingen zich op hun kerncompetenties zijn gaan concentreren zijn ze in toenemende mate afhankelijk geworden van hun toeleveranciers. Het is dan ook niet ongebruikelijk dat een overgroot gedeelte van de kosten van een onderneming zijn gerelateerd aan inkoop. Hierdoor worden inkoopmanagers in toenemende mate geconfronteerd met vragen over de verantwoording van hun inkoopbeslissingen en de daaruit resulterende prestaties. Tegelijkertijd zijn inkoopbeslissingen steeds complexer van aard als een gevolg van de strategische aspecten die erbij zijn betrokken. Er hebben zich dan ook belangrijke veranderingen in inkoopland voorgedaan die zich o.a. manifesteren in de opleidingsniveaus van het inkooppersoneel. Hetzelfde zou eigenlijk verwacht kunnen worden van de rol van informatietechnologie in de inkoop. Het tegenovergestelde lijkt echter waar te zijn; nog steeds lijkt inkoop achter te lopen als het gaat om de toepassing van moderne informatietechnologie (IT).

Dit ontwerpgerichte onderzoek onderzocht de wijze waarop IT kan worden ingezet om werkwijzen in de hedendaagse inkoop te ondersteunen

De uitdaging van dit onderzoek was om de bestaande kennis op het gebied van het gebruik van IT in inkoop uit te breiden. De belangrijkste onderzoeksvraag was welke IT functionaliteit mogelijkerwijs zou kunnen worden ingezet om de werkwijzen in de hedendaagse inkoop effectief te kunnen ondersteunen. Hierbij is aandacht geschonken aan de huidige stand van zaken en de redenen hiervoor. Bovendien zijn een aantal ontwerpprincipes en refentiemodellen ontwikkeld die dienst kunnen doen als richtlijnen indien inkoop ondersteund moet worden met behulp van informatietechnologie.

Om de onderzoeksvragen te beantwoorden was het ontwerpgerichte onderzoek in een drietal fasen onderverdeeld., te weten (1) een vooronderzoek, (2) analyse, en (3) ontwerp (incl. evaluatie). In de eerste fase is literatuuronderzoek verricht en zijn vier gevalsstudies uitgevoerd om inzicht te krijgen in de materie. Tijdens de analysefase is uitgebreid literatuuronderzoek verricht naar het gebruik van IT in de inkoop, en zijn bestaande informatiesystemen en referentiemodellen onderzocht en geëvalueerd. In de ontwerpfase tenslotte zijn meerdere gevalsstudies uitgevoerd om de bestaande kennis op het gebied van inkooptaken, procesen en situaties verder uit te diepen vanuit een ontwerpperspectief. Dit heeft geleid tot het definiëren van een vijftal ontwerpprincipes die vervolgens in twee gevalsstudies, een ontwikkelproject bij een softwareleverancier, en in verschillende workshops zijn geëvalueerd.

IT wordt tegenwoordig alom gebruikt in de inkoop, maar de geboden ondersteuning is daarbij nog steeds beperkt

Vanuit het onderzoek is gebleken dat IT tegenwoordig bijna overal in de inkoop wordt gebruikt. Het gebruik van IT is daarbij geëvolueerd vanuit het ondersteunen van de administratieve taken van de inkoper (in de zestiger jaren), rapportage en integratie met productieplanning (in de zeventiger jaren), tot beslissingsondersteuning en communicatie (in de tachtiger jaren). In de negentiger jaren zijn vele nieuwe technologieën ter beschikking gekomen waarvan de toepassing in inkoop nog in de kinderschoenen staat. Ondanks dat er vele geavanceerde toepassingen van IT in de inkoop in de literatuur te vinden zijn, is men in de praktijk veelal genoodzaakt genoegen te nemen met de mogelijkheden van standaard softwarepakketten. Deze pakketten geven voornamelijk ondersteuning aan het repetitief bestellen van eenvoudige, gecodeerde standaardproducten die een onderdeel vormen van het eindproduct. Het inkopen van meer complexe producten met uitgebreide specificaties wordt in veel mindere mate ondersteund. Verder wordt de inkoop van klantenorderspecifieke producten niet altijd ondersteund, evenals het uitbesteden van activiteiten en het inkopen van diensten. De bestaande referentiemodellen die zijn onderzocht gaven ongeveer hetzelfde beeld als de softwarepakketten.

Achtergronden bij de aangetroffen stand van zaken zijn (1) de gebruikelijke focus op de te behalen efficiëntie door de inzet van IT, (2) de moeilijkheden die inkoop heeft om haar toegevoegde waarde duidelijk te maken en te communiceren, (3) de ongestructureerdheid van sommige inkooptaken, en (4) het gebrek aan begrip tussen inkoop en IT professionals.

IT moet ondersteuning bieden aan initiële inkooptaken in situaties waarin relatief nieuwe en onbekende producten en/of diensten moeten worden ingekocht

Om het onderzoek meer richting te geven werd een viertal gevalsstudies uitgevoerd. De conclusies uit deze gevalsstudies gaven aan dat het gebruik van informatietechnologie gericht moest zijn op de ondersteuning van initiële inkooptaken zoals bijvoorbeeld marktonderzoek, leveranciersselectie, contractering, uitbestedingsvraagstukken, productontwikkeling, en planning in situaties waarin relatief nieuwe en onbekende producten en/of diensten moeten worden ingekocht. Bovendien bestond er behoefte aan de ondersteuning van prestatiemeting en -beoordeling in inkoop. Daar meer en meer bestaande softwarepakketten echter mogelijkheden bieden om prestaties te meten en te analyseren is het onderzoek vooral ingegaan op de manier waarop IT kan worden ingezet in de initiële inkoop. De karakteristieken van deze taken en situaties vragen om functionaliteit ten behoeve van (1) analyse, simulatie en evaluatie, (2) flexibele rapportages en vraagmogelijkheden, (3) communicatie, (4) het management van processen en capaciteiten, en (5) het uitgebreid kunnen vastleggen van gegevens en documenten.

Initiële inkoop omvat drie belangrijke taken, te weten (1) 'sourcing', (2) het vertegenwoordigen van inkoop in uitbestedingsvraagstukken, productontwikkeling en logistiek, en (3) inkoopmanagement

Initiële inkooptaken zijn in het onderzoek onderverdeeld in daadwerkelijke inkooptaken en inkoopmanagementtaken. Inkooptaken omvatten daarbij 'sourcing' (d.w.z., het definiëren van beleidsuitgangspunten op het gebied van toelevering en de rol van toeleveranciers, en het selecteren, kwalificeren en contracteren van toeleveranciers), en het vertegenwoordigen van inkoop- en toeleverinsgaspecten in vraagstukken rondom uitbesteding, productontwikkeling en logistieke planning.

Het is ook gebleken dat vele verschillende gebeurtenissen kunnen leiden tot het uitvoeren van inkoopactiviteiten. In de praktijk is dan ook vaak sprake van een groot aantal, parallel lopende inkoopprocessen die steeds vaker van een complexe en langdurige aard zijn. Vanwege de complexiteit en het belang van deze processen worden ook steeds vaker bewuste inkoopmanagementtaken uitgevoerd. Hieronder vallen bijvoorbeeld taken als het opstellen van inkoopprocedures en beleidsuitgangspunten, (multi-) projectmanagement en het initiëren en bewaken van inkoopactiviteiten.

Inkoop voert haar taken in vele verschillende manieren uit, voornamelijk als een gevolg van verschillen in het belang van een bepaald geval en de onzekerheid die ermee samenhangt
In de praktijk worden inkooptaken veelal op een van geval tot geval verschillende wijze ingevuld. Uit het onderzoek is gebleken dat inkoop daarbij zich vooral richt op het wegnemen van de onzekerheden die met een bepaald geval samenhangen. Dit gebeurt dan voornamelijk door het vergaren van gegevens en het communiceren daarover. De inspanningen die men zich daarbij getroost hangen ook af van het belang van het geval. Dit belang en de onzekerheden zijn bepalend voor het risico dat men loopt bij uitbesteding van een bepaalde activiteit.

Vervolgens zijn een vijftal ontwerpprincipes voorgesteld ten behoeve van het ontwerpen van inkoopondersteunende systemen gebaseerd op IT
Vanuit de kennis die is opgedaan tijdens het onderzoek is een vijftal ontwerpprincipes opgesteld die tegemoet moeten komen aan (1) de gevonden verschillen tussen inkoop en inkoopmanagementtaken, (2) de steeds uitgebreidere gegevensverzamelingsactiviteiten tijdens de initiële inkoopfase, (3) de verschillen die kunnen bestaan met betrekking tot de bekendheid met de gevallen die moeten worden afgehandeld, (4) de diversiteit van de gevallen in de inkoop, en (5) de veranderlijkheid van de wijze waarop gevallen worden afgehandeld, zelfs tijdens de afhandeling zelf. De vijf ontwerpprincipes die op basis van het bovenstaande zijn opgesteld zijn:

1. **Maak onderscheid tussen ondersteuning voor inkoop en inkoopmanagement.** IT functionaliteit moet gegroepeerd worden in 'toolkits' voor inkoop en voor inkoopmanagementtaken. Systemen voor inkoopmanagement moeten gegevens bevatten omtrent processen, capaciteiten, documenten, en 'tools' die in de inkoop kunnen worden gebruikt. Op dit gebied zijn reeds vele algemene 'tools' beschikbaar die kunnen worden ingezet in de inkoop. Dit betekent echter wel dat inkoopprocessen moeten worden geëxpliciteerd en gedocumenteerd. Systemen voor specifieke inkooptaken moeten gegevens bevatten over de toelevering zoals toeleveranciers, contractrelaties, uitbestede activiteiten en ingekochte producten.
2. **Verschaf uitgebreide ondersteuning voor inkoop 'nieuwe stijl'.** IT systemen moeten de mogelijkheid bieden om uitgebreide modellen van de toelevering en de daarin acterende toeleveranciers vast te

leggen om tegemoet te komen aan behoeften aan ondersteuning op het gebied van inkoopbeslissingen als het bijvoorbeeld gaat om Early Supplier Involvement, en de keuze van mogelijke partners.

3. **Bij min of meer bekende gevallen, moet gebruik kunnen worden gemaakt van referentiegegevens.** Indien mogelijk (hetgeen afhankelijk is van de bekendheid met het geval), moeten informatiesystemen referentiegegevens kunnen verschaffen over gelijksoortige gevallen. Dit betreft dan zowel gegevens over mogelijke oplossingen voor het geval als gegevens over de manier waarop het geval zou kunnen worden afgehandeld.
4. **Verschaf generieke ondersteuning om tegemoet te komen aan de grote diversiteit aan inkoopsituaties.** Wanneer systemen ondersteuning zouden moeten bieden aan een veelheid van mogelijke gevallen en werkwijzen (hetgeen zich bijvoorbeeld kan uiten in een groot aantal checklists, leveranciersprofielen, inkoopprocedures, inkoopdocumenten, etc.) zou gebruik moeten worden gemaakt van de mogelijkheden die generieke objectmodellen bieden.
5. **Verschaf aanpasbare ondersteuning om dynamische processen te kunnen ondersteunen.** Wanneer een systeem aanpasbaar moet zijn om ondersteuning te kunnen bieden aan gevallen waar bij aanvang nog vele onduidelijkheden bestaan zou eveneens gebruik moeten worden gemaakt van de mogelijkheden die generieke objectmodellen bieden, bijvoorbeeld op het gebied van het flexibel definiëren van benodigde gegevens.

In een IT architectuur moet vervolgens een onderscheid worden gemaakt tussen applicaties ter ondersteuning van algemene inkoopmanagementtaken, applicaties ter ondersteuning van specifieke inkooptaken, een interface bestaande met document managementfunctionaliteiten, en alom aanwezige communicatiefunctionaliteiten.

De vijf ontwerpprincipes blijken nuttig en toepasbaar te zijn, alhoewel vragen rondom integratie en de benodigde inspanning blijven bestaan

De vijf ontwerpprincipes zijn geëvalueerd in twee gevalsstudies waarin prototypes zijn gebouwd gebaseerd op de principes. Dit maakte het mogelijk om de principes door potentiële gebruikers te laten beoordelen en om kwesties betrekking hebbende op een eventuele implementatie te achterhalen.

De eerste gevalsstudie richtte zich op het ontwikkelen van een prototype ter ondersteuning van leveranciersselectie. Uit de behoefte-inventarisatie die is uitgevoerd bleek wederom het belang van flexibiliteit in systemen ter ondersteuning van initiële inkooptaken. Bovendien moet het prototype een veelheid aan verschillende selectieprocessen kunnen ondersteunen. Om te kunnen identificeren of selectieprocessen moeten worden uitgevoerd is het nuttig om een systeem ter ondersteuning van leverancierselectie te voorzien van 'monitoring' mogelijkheden. Verder moest het systeem verschillende, uitgebreide beoordelingssystematieken (met behulp van 'checklists') ondersteunen. Functionaliteiten om gegevens op te vragen zijn uiteraard eveneens van groot belang. In de evaluatie van het prototype werd aandacht geschonken aan (1) de integratie van systemen gebaseerd op de ontwerpprincipes met andere, meer traditionele systemen, en (2) de distributie van gegevens. Verder werd de toegang tot belangrijke gegevens, en de stimulans die het systeem vormt om op een transparante, gestructureerde en consistente wijze te werk te gaan in dit soort processen als de belangrijkste voordelen gezien.

Het tweede prototype was gericht op het ondersteunen van contracterinsgactiviteiten in de inkoop. In deze activiteiten spelen documenten een uitermate belangrijke rol. Daarbij is in het prototype een onderscheid gemaakt tussen referentiedocumenten en specifieke documenten. Andere belangrijke aspecten zijn het voorkomen van zogenaamde 'stippellijn' (invul-) elementen in documenten, het feit dat het vaak om gelijksoortige en gestructureerde documenten gaat, en dat veel van de teksten in documenten kunnen worden gebruikt in vele verschillende specifieke documenten. In de evaluatie werden de mogelijkheden die een systeem gebaseerd op de ontwerpprincipes biedt om kennis omtrent de toepasbaarheid van contracten vast te leggen en vanuit deze kennis contracten te genereren, als zeer waardevol gezien. Om deze voordelen echter ook te kunnen benutten moeten echter wel behoorlijke inspanningen worden geleverd om documenten en processen opnieuw te structureren en om juridische kennis te expliciteren. Ook hier werd wederom aandacht besteed aan de noodzaak voor integratie met traditionele systemen.

Verder onderzoek op het gebied van inkoop en informatietechnologie

Elk onderzoek is natuurlijk in zekere zin beperkt, en geeft aanleiding voor nader onderzoek. Mogelijke onderzoeksonderwerpen volgend vanuit deze studie kunnen worden gegroepeerd naar onderzoek op het gebied van inkoop, onderzoek op het snijvlak van inkoop en informatietechnologie en onderzoek op het gebied van informatietechnologie.

Op het gebied van inkoop zou aandacht kunnen worden geschonken aan de rol die inkoop, maar ook leveranciers, zouden moeten spelen in vraagstukken rondom uitbesteding, productontwikkeling en logistieke planning. Bovendien zou een ontwerpgerichte studie aandacht kunnen schenken aan de wijze waarop deze rollen zouden kunnen worden ingevuld. Ook zou aandacht kunnen worden besteed aan de wijze waarop inkoopprocessen en inkoopmanagementtaken zouden kunnen worden gestructureeerd en worden ingevuld om te komen tot prestatieverbeteringen in de inkoop.

Op het snijvlak van inkoop en informatietechnologie zou aandacht kunnen worden besteed aan een gedegen kosten-baten evaluatie van het gebruik van IT in de inkoop. De veelal gedistribueerde aard van inkoopactiviteiten en de implicaties daarvan voor de ondersteuning van inkoop met IT vormt een ander interessant punt op de onderzoeksagenda. Daarnaast vormen nieuwe ontwikkelingen op het gebied van IT zoals het Internet, maar ook het gebruik van de 'purchasing card' mogelijkheden om onderzoek uit te voeren.

Als laatste is het zinvol om de toepassing van het generieke objectmodel verder te bestuderen op toepasbaarheid en randvoorwaarden (denk bijvoorbeeld aan de integratie-problematiek, waarbij documenten een belangrijke rol kunnen spelen). Dit impliceert ook dat het expliciteren en beheren van kennis over een bepaald domein belangrijke aandachtspunten zijn in verder onderzoek.

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Introduction

From the start of the computerization of business, purchasing has been perceived to lag behind other organizational functions as marketing, product development, and logistics in its assimilation to information technology (IT). IT is called upon merely to perform fairly routine purchasing tasks. This was the conclusion that Moore and Fearon (1974, pp. 30-39) and Parasuraman (1981, pp. 10-14) once drew. And although computer usage rates in purchasing have increased continuously over the last two decades, the type of tasks in which IT is used still seems to be limited to the type of activities identified by Moore and Fearon. For example, as Plank, *et al.* examined the use of computers in purchasing departments in 1992, they found a 98.2% computer usage rate amongst 107 respondents in their survey, as against the 53% Moore and Fearon once found. However, purchasing activities addressed in the survey mainly involved administrative tasks such as maintaining vendor lists, inventory records and purchase order status, preparing purchase orders, correspondence and memos, and operational planning activities such as MRP. When activities such as performance measurement and quotation management were addressed the computer usage rate dropped to 44.7% resp. 14.5%. Scheuse (1994, pp. 52-54) in his study claims that activities beyond the operational level were covered in only 10-20% of all cases. According to a recent UK survey of the Computer Management Group — a well known European computing services company — 70% of the respondents felt that their needs were only adequately or even less met by the automated information system that was in place (Purchasing & Supply Management, 1995, p. 13).

CHAPTER CONTENTS

This study answers three main questions, viz., (1) *what* is the current state of affairs concerning the application of IT in purchasing, (2) *why* seems there to be so little progress in the use of IT in industrial purchasing, and (3) it provides directives and reference models that can serve as a guide in *how* to support purchasing processes in industry with the aid of information technology. In this way this study supports the effective and efficient development and selection of information systems for the industrial purchasing function.

The intended audience consequently primarily consists of business analysts, information analysts, and IT specialists from both software companies and system development departments. However, purchasing managers and management consultants that are responsible for managing or improving purchasing practices can also benefit from the concepts presented in this study.

This first and introductory chapter describes why it is important and actual to study the theme of information technology in purchasing, and how this study was structured and taken on. It presents the purpose, importance, nature and scope of the study as well as the research design. Therefore it sets the stage for what comes after, by putting important parts of the topic area in their proper perspective and introducing the contents of the rest of the dissertation.

THE IMPORTANCE OF EFFECTIVE PURCHASING

No company is self sufficient or autarkic and every company therefore by definition depends on suppliers and contractors to meet a variety of organizational needs. Both manufacturing, support and management processes require materials, components, goods, equipment, supplies, merchandise, but also (specialist) services. Consequently, purchasing is a function that is required in every organization, from the private household to the large industrial corporation and even national governments.[1]

[1] As the term 'purchasing' is one of the fundamental concepts in this dissertation it is defined accurately and in detail in a later section of this dissertation (Chapter 5). For now, the intuitive understanding of 'purchasing' as to buy something, to obtain something by paying money suffices.

In the last two decades, the increasingly complex, dynamic and extremely competitive environment of today's industrial company has added to the importance of purchasing. One of the major strategic implications of coping with this new environment has been a strategic re-orientation on the degree of vertical integration (Barreyre, 1988, pp. 507-520). Business strategy has been moving away from in-house manufacturing towards an ever increasing dependence on suppliers and subcontractors.

In recent years therefore, more and more companies have realized that a significant share of their annual sales turnover is related to the purchasing of goods and the contracting out of services. Although the administrative expense of most Purchasing departments only ranges from 1-3% of the total company costs (Cavinato, 1991), in Dutch industry the costs of bought materials and subcontracted services are about 55% of the annual turnover (CBS, 1991).[2] When 'other expenses',[3] which includes a large portion of purchase and subcontracting expenses, are added to this, Van Weele claims this share even to be 68% (Van Weele, 1994, p. 12). As can be concluded from several other sources (Hay, 1988; Ansari *et al.*, 1988, pp. 19-26; Baily and Farmer, 1990; Cavinato, 1991), these figures are not only typical for Dutch industry, but also for industry in other industrialized countries. Companies like Canon and Sony even show figures of c. 90% (Telgen, 1994, p. 20). Consequently, the purchasing function plays an important role in an organization's profit making ability. The importance of purchasing is sometimes illustrated with the purchasing profit multiplier[4] (see, e.g., Zenz, 1994, pp. 7-8). The purchasing profit multiplier for alternative gross margins is shown in Table 1-1 as the equivalent amount of sales increase needed to equal a $1 savings in purchasing.

[2] This is calculated on the basis of invoices of the purchased goods (raw materials and expedients, and packaging) and subcontracted work carried out by third parties, exclusive purchase taxes and recovered import duties and levies.

[3] 'Other expenses' comprise the rent of buildings, sites, machinery, installations and transport, banking expenses, the costs of maintenance and insurance, auxiliary materials, company cars, communication like phone and fax, stationery, and the charges for subscriptions, advertisements and professional services.

[4] This multiplier indicates the amount of sales increase necessary to equal a dollar saved in purchasing, assuming a specific gross profit margin.

TABLE 1-1. Purchasing Profit Multipliers

Gross Margin (%)	*Purchasing Profit Multiplier ($)*
2.5	40.00
5.0	20.00
7.5	13.33
10.0	10.00
15.0	6.67

Source: Zenz, 1994, p. 8

Similarly, but then illustrative of the effect of purchasing savings on the return on net assets instead of profit, the Du Pont chart is often used as a means in indicating the importance of purchasing (see, e.g., Van Weele, 1994, pp. 12-13). An example illustrating the effects of a 2% savings in purchasing on the RONA depicted in Figure 1-1.

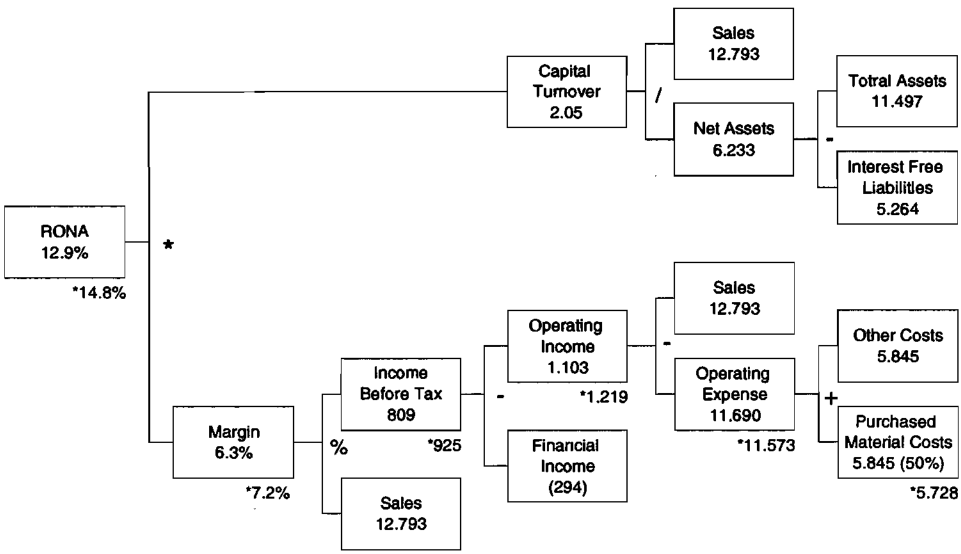


FIGURE 1-1. The effects of purchasing savings on a company's return on net assets (RONA), indicated by an *. Amounts are in ECU million. *Source*: adapted from Van Weele, 1994, p. 13.

The above figure indicates that effective purchasing essentially contributes to improving the company's RONA in two ways (Van Weele, 1994, pp. 12-13). First, through a reduction of all direct materials cost (by, e.g., cutting purchase prices), and second, through a reduction of the net capital employed by the company. The latter implies, a.o., significant inventory reductions by, e.g., adopting the Just-in-Time (JIT) philosophy or implementing Total Quality Management (TQM) programs. The success of these efforts depends to a large extent on purchasing. Effective purchasing is, however, not only about lower materials costs and capital employed. Proactive management of the supplier base and early involvement of the suppliers in the product development process cannot only lead to significant cost reductions; it may also strengthen the company's innovative power and its competitive position (Van Weele, 1994, p. 14, 143-148).

As purchasing decisions can have far-reaching effects on the efficiency and effectiveness of a company's operations as well as the company's products and use thereof throughout the product life cycle, purchasing undeniably is — and in the future will be — of utmost importance to the whole of the company.

Given the significance of purchasing outlined above, it can be concluded that purchasing has an important effect on the profitability of an organization and that it forms an important (potential) source of competitive advantage for many industrial companies. Therefore, there is too much at stake for the company's purchasing activities not to be well equipped and professionally organized, and not to form an integrated part of the organization.

DEVELOPMENTS IN INDUSTRIAL PURCHASING

As the importance of purchasing decisions has increased, so has the basis for these decisions (i.e., the considerations and arguments that underlie purchasing decisions). Due to the increased attention of top management, purchasing managers nowadays are more and more confronted with questions concerning the rational justification of their decisions and are held responsible for the performance resulting from these decisions. This has resulted in an increased attention for measuring performance and for making the bases of purchasing decision making more explicit. At the same time, however, this demand for well considered purchasing decisions has also led to an increased complexity and unclearness of purchasing decision making. Whereas in earlier days purchasing decisions were often justified through the use of a single (often price) criterion, nowadays, multiple and often 'soft' criteria of which the exact influence upon the decision is not very clear, play a role in purchasing decision making.

The increased importance of purchasing has also produced a significant shift from the 'traditional' way in which purchasing decisions were made. Traditionally, purchasing operated as a stand-alone function and its activities were confined to receiving material requests from user departments and translating these into purchase orders or other contractual relationships with suppliers. As a result, in the past, purchasing was a reactive, paperwork and procedurally dominated function. Purchasing practitioners were characterized as clerks, reactive to circumstances in their environment. In this relatively stable and transparent environment, purchasing decision making was of a repetitive and routine nature. The purchasing decisions were fairly well structured (or programmed), and mainly addressed short term operational issues.

In recent years, however, purchasing went through quite a change of perspective: from 'purchasing' (an operational function) to what Kraljic called 'supply management' (a more strategic one) (Kraljic, 1983). To cope with the increased significance of purchasing and environmental uncertainties, buyers are no longer just processors of requisitions and order forms, but increasingly also need to take on strategic roles within organizations (see, e.g., Spekman, *et al.*, 1994, p. 77). It is no longer unusual that purchasing managers report directly to the board of directors instead of being a part of the production function, because the strategies that purchasing develops are now considered to assist in achieving the organization's overall goals and objectives (Fearon *et al.*, 1993). They now take part in decisions concerning supply chain management, product input, supply alternatives for the firm and they participate in future strategy formulation processes (Cavinato, 1991). In doing so, purchasing decision making is expanding. For example, purchasing more and more establishes integrative links with logistics, production preparation and product development (Van Weele, 1994). So, purchasing — as well as other business areas — is shifting towards less compartmentalization and greater integration with other areas of the firm (Freeman *et al.*, 1990). Furthermore, purchasing more and more has to learn to make things happen to its own advantage (Kraljic, 1983). Purchasing has to anticipate and develop appropriate strategies for dealing with factors that influence the supply of the company. Purchasing takes the lead in many of these efforts as opposed to simply responding to the action of others, and as a result it has a new, pro-active and assertive role within the firm (Cavinato, 1991; Fearon *et al.*, 1993, pp. 6-10). These changes in purchasing are characterized in Table 1-2.

TABLE 1-2. Developments in Purchasing Decision Making[5]

	'Traditional' Purchasing	*'Contemporary' Purchasing*
	short term	long term
Purchasing	operational	strategic
Goals	single objective	multiple objectives
	efficiency	effectiveness
	transparent	unclear
Purchasing	stable	dynamic
Decision Making	programmed	non programmed
	structured	ill structured
	repetitive	unique
	routine	ad hoc
Purchasing	procedural	non procedural
Process	administrative	non administrative
	isolated	integrated
	monodisciplinary	multidisciplinary
	reactive	pro-active, anticipative, assertive

Source: De Boer and Van Stekelenborg, 1996, p. 175.

INFORMATION TECHNOLOGY IN PURCHASING

The shift described in the previous section has had a significant effect on the resources (i.e., purchasing personnel and systems) used in the 'contemporary' purchasing process.

The shift is, for instance, clearly reflected in the educational level of purchasing personnel. To meet the demands of the new role purchasing takes up in organizations, companies upgraded the skills and experience it requires of key purchasing people (Kraljic, 1983; Van Weele, 1994). Traditionally, buyers' education levels were low and they performed mainly clerical duties, being excluded from more tactic and strategic level decision making. Over the last decade, however, there has been a dramatic increase in the professional and academic qualifications of purchasing personnel (Cousins, 1992; Telgen, 1994, p. 25).

[5] Please note that the use of the words 'traditional' and 'contemporary' does not imply that contemporary purchasing does not have anything to do with efficiently handling purchase requisitions anymore. They are only used to illustrate a shift in the mix of purchasing characteristics.

Comparably, the same could also be expected from the typical use of IT in purchasing. Supported by Child (1987, pp. 33-50), who notes that "the information processing requirements of enterprises are expanding as their competitive environments become more dynamic and volatile", it can be argued that purchasing has a growing demand for information technology supportive to purchasing decision making and its management. This also corresponds with the viewpoint Galbraith took in his well-known book "Designing complex organizations" (1973), when he stated that "the greater the uncertainty of the task, the greater the amount of information that has to be processed ... in order to achieve a given level of performance". It is also therefore that industrial companies are increasingly dependent on an adequate information provision geared to the way the business is managed. To provide this information, companies make use of IT. Consequently, IT plays a crucial role in the industrial company of today. It is even hardly imaginable that present-day companies can do without IT. This was also recognized by Zachman (1987, pp. 276-292) when he posed that the success of future companies to a large extent would depend on the effective use of IT in its management. Moreover, IT even forms an essential enabler in permitting companies to respond to the constantly changing industrial environment (Hammer and Champy, 1993, p. 83).

In a Dutch study (Van Weele, *et al.*, 1987), purchasing managers expressed this relation as they posed that the use of IT in their tasks was expected to be the primary tool to improve their functioning (p. 90). In a recent study by Van Weele and Rozemeijer (1996), the authors even pose that IT is the enabler without which advancement in purchasing and supply management will not be possible (p. 116). Plank, *et al.* (1992) also argue that IT "plays an important role in the transition that is currently taking place [in purchasing] and is, in fact, driving many of the changes occurring today" (p. 245). Without question, the effective application of IT in purchasing and supply management is one of the most significant tools to survive in today's competitive environment, and a prerequisite to enable change.

The Industry Snapshots on the following page are illustrative of the described relationship between information technology and purchasing strategy. They point out the importance of IT in realizing a company's strategic goals and the increased need for IT support in a purchasing environment.

INDUSTRY SNAPSHOT 1-1. The NAM Procurement Systems Strategy

Mid 1992, the NAM — a Royal Dutch/Shell Operating Company (OpCo) responsible for exploration and production of oil, gas and condense in the Netherlands and the Dutch continental shelf — decided to significantly further outsource many of their non core operations and to decentralize procurement activities. It was recognized that many of the benefits of this Business Change Plan (known as TSS2000) could only be realized with the development of new appropriate business supporting system solutions, and that it would require different staff profiles. Early 1993 this resulted, among other things, in the NAM Procurement Systems Strategy. This strategy was explicitly developed to support the changing business direction identified in TSS2000. The strategy covered both technical topics (such as data bases, user interfaces, and hardware standards) and development issues. The main target was to provide fit for purpose business driven developments within an acceptable time span of less than 12 months.

INDUSTRY SNAPSHOT 1-2. The Intervam Purchasing Information Study

Intervam — a subsidiary company of the Dutch building firm HBG — aimed at substantial improvement of the quality of their suppliers and subcontractors as Intervam experienced their increasing dependency on supply performance. Also, they expressed their wish to be able to exploit their (central) purchasing power in negotiations with their suppliers and subcontractors. One of the major drawbacks for realizing these objectives, however, was their ineffective purchasing system ICS (the Purchasing Coordination System). Mid 1994, a working group was therefore started up that got the assignment of investigating the benefits of developing or selecting a purchasing information system, and defining the required functionality.

INDUSTRY SNAPSHOT 1-3. The Purchasing Information Plan at Philips Medical Systems Nederland

Philips Medical Systems — one of the product divisions of the Dutch multinational Philips Electronics — is a world wide operating supplier of diagnostic imaging equipment for medical purposes, related therapeutic equipment, and of accompanying services to hospitals. Together with General Electric, Siemens and Toshiba, Philips Medical Systems (PMS) belongs to the four largest suppliers of medical equipment in the world. The former purchasing manager of the X-Ray Systems unit in Best (the Netherlands) was confronted with an increased need to measure performance of both suppliers and of its purchasing process. In 1991, a Purchasing Information Planning Study was therefore started up that aimed at the mapping of existing purchasing processes and the defining of relevant performance measures.

Although the industry snapshots on the previous page provide ample examples of the relationship between changing purchasing strategies and the need for supportive information systems, this has not yet led to *generally* accepted, successful and proven implementations. Most of the examples above are fairly recent, and even the companies mentioned are still in search of effective purchasing information systems. As the introduction of this chapter also illustrates, the use of information technology in purchasing is still mostly limited to the support of the 'traditional' purchasing function.

But what are the consequences of this situation for purchasing? First, as Kraljic noted (1983), the purchasing department too often receives information that is incomplete or improperly geared to the tasks and time horizons that belong to the new paradigm in purchasing. Purchasing managers often lack adequate information with a medium to long term time horizon necessary to anticipate the uncertainty of the present environment. In absence of data supporting medium term and long term decision making in purchasing, supply bottlenecks, short term demand fluctuations and ad hoc purchasing decisions are inevitable. In this context as well, Galbraith (1973) states that "in the case of uncertainty, ... the organization estimates factors, treats them as certainty equivalents, and processes them as in the certainty case". But he adds that "the estimates will probably be wrong". It is obvious that purchasing — when confronted with increased uncertainty — has to estimate key decision making variables resulting in a greater probability of making inferior decisions. Considering the significance of present day purchasing, it is therefore clear that the cost-effective use of IT can contribute to the performance of the company as a whole. Moreover, as we already have seen, IT is an essential enabler in allowing purchasing to respond to its constantly changing environment.

THE RESEARCH

Research Objectives

As any doctoral thesis in a professional discipline, the main purpose of this dissertation is to increase knowledge about a matter relevant to the practice of the particular profession; in this case this 'matter' relates to IT, and the 'profession' is contemporary industrial purchasing. The knowledge that is accrued in this dissertation thereby not only validates or brings into question aspects of current professional applications of IT in industrial purchasing, it also serves as the basis for creating new and more effective applications of IT. In this way it provides knowledge to enable advancements in and further professionalization of purchasing and supply management practices.

Furthermore, this study hopes to reinforce the attitude of using more objective and systematic approaches in the field of industrial purchasing and, in general, it hopes to foster and guide the improvement of the profession of industrial purchasing as a whole.

Design Directives and Reference Models. The newly accrued knowledge on both required as well as potentially beneficial applications of IT in contemporary industrial purchasing must be recorded in a proper and useful way. Therefore this knowledge is translated into concrete design *directives* that support the specification of requirements from a purchasing perspective. Furthermore we make use of *models*, which can be defined as simplified constructions of the actually complex reality of industrial purchasing that has been investigated, an abstraction of reality (In 't Veld, 1988, p. 99). When this knowledge and experience is recorded in a model with a more general validity, i.e., valid for a range of situations, these models are called *reference models*. This implies that not a particular organization, organizational process or system is taken as a starting point, but a generic one. A reference model can therefore be seen as an abstraction of specific models, as an abstract or conceptual model of 'capitalized' knowledge and experience. Therefore the knowledge gained in this research is not only recorded in a set of design directives but also in a set of reference models (more in particular in process and data models, which are considered to be the most important models in requirements modeling (see Bemelmans, 1991, p. 224)). The directives and reference models can be interpreted as the main results of the research. These directives and models can subsequently be used in more effectively and efficiently developing as well as selecting software supportive to contemporary industrial purchasing.

Using Directives and Reference Models. Based on Davis (1982, p. 12), Bemelmans (1991, pp. 155-158) distinguishes among four strategies for determining information needs: the waiter strategy, the referential strategy, the development strategy and the iterative or evolutionary strategy.

The first strategy, the waiter strategy, is a strategy of questioning future users. It therefore makes use of methods and techniques like interviews, questionnaires, brainstorming and Delphi. It is mostly used in tackling well structured problems, and in an environment in which well trained developers and a limited number of knowledgeable and experienced users are available.

The referential strategy identifies information needs by taking (the designs of) existing systems as a reference. By comparing the situation with comparable situations and system used in those situations, a first draft of a suitable system can be made. It is obvious that the availability of reference systems or designs (or reference models) is a prerequisite for this strategy.

The development strategy is mostly adopted when no reference systems or designs are available, problems are more difficult to structure, and user experience is only average. This strategy makes use of careful analysis techniques like Critical Success Factors analyses (CSF), and sociotechnical, operations research, and process oriented techniques to specify information needs in a particular situation.

Finally, when much uncertainty regarding system specifications exists, and both users and developers lack the required knowledge, the iterative or evolutionary strategy is adopted. This strategy uses an incremental approach, i.e., the development and construction of information systems takes place in small steps. A data oriented approach and extensive use of prototypes is therefore also customary in this strategy.

A referential strategy has the advantage over the other strategies that use can be made of the 'capitalized' knowledge of experts in the field and experiences of other IT users in purchasing.[6] This results in more effective applications as well as reduced maintenance efforts afterward, mainly because of the more complete and correct specifications that follow from adopting a referential strategy (Greveling, 1990, pp. 92-93).[7] The strategy settles with the frequently mentioned problems in identifying information needs, viz., (1) the complex and varied information needs, (2) the difficulties in the communication between software developers and end users, (3) the possible resistance (for whatever reason) of end users to cooperate, and (4) the limited capability of humans in specifying information needs (Bemelmans, 1991, p. 155). This study aims at providing reference models to enable practitioners to use a referential strategy in developing or selecting IT applications for purchasing. In that way, the discussed benefits resulting from the referential strategy can be harvested.

[6] In this way reference models also are preeminently suitable for the recording of theories in a specific domain.

[7] Assuming that the reference models that are used in this strategy are complete and correct.

Research Questions

Clearly the challenge of this research is to increase the currently existing knowledge on the effective use of IT in contemporary industrial purchasing. This knowledge should be laid down in design directives and reference models so that they can be used in a referential strategy. This knowledge thereby not only concerns currently existing IT applications in industrial purchasing, but also knowledge required in creating new and more effective IT applications. The central question in this research therefore is:

- **What IT functionality is required and can be applied to effectively support contemporary industrial purchasing?**

To answer this central question, several sub questions were answered first. These questions concerned the state-of-the-art in IT application in purchasing, the purchasing tasks or decisions and the typical purchasing situations that can be come across in the industrial purchasing practice, and the corresponding purchasing processes. This is further detailed below.

State of the Art. As in any research, it is senseless to 're-invent the wheel' and therefore, before developing the required reference models, the current state of the art in this domain first had to be covered in detail. This results in the first important set of research questions that are answered in this dissertation:

1. What is the current *state-of-the-art* in IT for industrial purchasing?
2. What is the typical *support* this IT provides for contemporary industrial purchasing?
3. What are the main *reasons* for this state of affairs concerning the application of IT in industrial purchasing?

After having assessed the currently existing coverage of IT in industrial purchasing, the 'blank spots' (i.e., areas that are currently not well or not at all supported by IT) could be identified. In this way the answers to these first research questions also made it possible to focus the remaining research efforts on those areas that are currently not well supported by IT.

Purchasing Decisions. Then, to answer the central research question on functionality and to subsequently record this knowledge in a set of reference models, Greveling in his dissertation suggests a method that is strongly influenced by Bemelmans (Greveling, 1990, pp. 205-211). This method prescribes that it is first necessary to gain insight in the decisions that have to be supported by IT (Bemelmans, 1991, p. 26). The planning, execution and evaluation of business activities implies selecting the right alternative out of many. To make this choice in a considered way, information is needed on the reasons for this choice and the possible consequences resulting from this choice. From the foregoing it is obvious that the gathering of information and decision making are indissolubly connected to each other. In the field of industrial purchasing this implies that the functional requirements upon the systems are dependent on the purchasing decisions that have to be supported. Making purchasing decisions also involves selecting the right alternative out of many (just think of picking the right supplier, what brand to buy, how many sources to use, when and how much to order, etc.). An essential research question that is answered in this study therefore is:

4. What *purchasing* decisions are involved in contemporary industrial purchasing that require IT support?

Purchasing Situations. For the development of the reference models for those decision areas in industrial purchasing that are currently not well — or even not at all — supported by IT, it is necessary to investigate the characteristics of the decision making processes that have to be supported. These 'characteristics' concern the various decision making situations as well as the way a purchasing decision is made. The latter implies an analysis of the decision making models that are used in purchasing, i.e., what are decision objectives and relevant decision criteria, how do they relate to each other, etc. When applying this viewpoint to the research issue, this resulted in the following set of research questions that are answered in this dissertation, namely:

5. What typical decision making *situations* can be identified in contemporary industrial purchasing?
6. *How* are decisions made in the various typical purchasing decision making situations (*model* considerations)?

Purchasing Processes. In addition to the model considerations on purchasing decisions, process considerations also play a very important role in determining the required and possible IT functionality in purchasing. This implies that the various steps in the decision making process have to be identified and described. Furthermore, an analysis of the way in which these processes are or could be managed provides the basis for specifying IT tools that are supportive to the management of purchasing processes. A final set of research questions that are answered in this dissertation therefore was:

7. *How* are the various identified purchasing decisions reached (*process* considerations)?
8. How are the purchasing decision making processes *managed*?

Only then, when all the foregoing sub questions have been answered, the central question of this research, i.e., the question of what IT functionality is required or can be applied to effectively support contemporary industrial purchasing, can be answered.

Scope of the Research

Both the field of information technology and purchasing leave room for numerous issues to be studied. The research was therefore delimited to consider only the functional requirements on the model and data bases of administrative IT that can be used in the industrial purchasing of goods and services.

Industrial Purchasing. Notwithstanding that the issues described in this study might also exist in other economic sectors than industry, such as the service and public sector, this study focuses on industrial purchasing. In the last sections of this dissertation, however, attention is paid to the use and relevance of the developed reference models in other economic sectors.

Goods and Services. Although the purchasing process may concern a large variety of goods and services (see Table 1-3), no further demarcation was made regarding the type of goods and services being purchased. This also offers the possibility of applying the knowledge acquired in this study to be applied to other economic sectors (which is discussed later on in this study).

TABLE 1-3. Classification of Purchased Goods and Services

		Needs arising from the Company's Primary Process		*Needs not arising from the Company's Primary Process*
		Products are Transformed	*Products are Not Transformed*	
Purchased Goods	*Repeating Needs*	**Group 1:** Normal Raw Materials and Semi Finished Products	**Group 2:** Supplementary Materials	**Group 3:** E.g., Office Supplies
	Non Repeating Needs	**Group 4:** Exceptional Raw Materials and Semi Finished Products	**Group 5:** E.g., Machine Parts	**Group 6:** E.g., Infrastructure Investments
Contracted Services	*Repeating Needs*	**Group 7:** Subcontracted (Specialist) Operations, e.g., Transport		**Group 8:** E.g., Catering, Cleaning
	Non Repeating Needs	**Group 9:** Exceptional Subcontracting		**Group 10:** E.g., Consultancy

Source: Ribbers and Verstegen, 1992, p.124.

Administrative IT. IT comprises a wide field of possible application areas ranging from IT applications for use in administrative business processes, the use of IT in process automation, to the use of IT in the actual product or service. This dissertation, however, mainly focuses on the application area of automated information systems for use in business processes (i.e., administrative IT), although the other application areas are taken into account in the research where useful. In this study an information system[8] is defined as a system for input, storage, processing and provision of

[8] Properly speaking, information systems are actually data processing systems. Data are facts or notions that are represented in a form that is suitable for communication, interpretation and processing. Whether a data processing system actually provides information is not decided by the data processing system, but by the user of the system (e.g., a purchasing professional or manager). *Information* is the knowledge that a purchasing professional or manager derives from the provided data. In the true sense of the word it is therefore

data, whether automated or not, on behalf of a specific process (Greveling, 1990, p. 5). In this dissertation only automated information systems are considered. These are information systems that make use of information technology (IT).

Model and Data Base. An automated administrative information system essentially consists of four main components, which can be designed in various ways repeatedly. These four components are (Bemelmans, 1991, p. 244):

1. a *program* or *procedure base,* consisting of the set of data processing programs and procedures utilizing models for, e.g., analysis, planning, control and decision making (therefore sometimes referred to as a *model base*);
2. a *data base,* consisting of the set of data needed for producing administrative information;
3. a *user interface* for communication between the human user and the automated information system; and
4. a *system interface* for transferring data from one system to another, which more and more takes place by way of communication networks.

Another restriction to the scope of the study is related to these four components. The research only considered the model and data base components of an automated information system. This choice was made because of the extreme importance of these first two components for the functionality of the system (Bemelmans, 1991, pp. 147-154). It should be noted, however, that the success of any information system to a large extent is of course also dependent on the user and system interfaces of the system.

impossible to talk about 'information' systems. The better the design of the data processing system is adjusted to the needs of the users, the higher the probability is that a user experiences the system as significant and can draw information from it. Because of the fact that the use of 'information system' instead of 'data processing system' has become established, in the remainder of this dissertation use is made of the notion of information system.

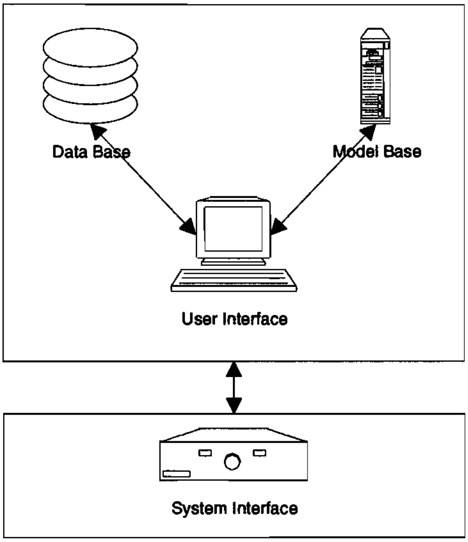


FIGURE 1-2. The typical components of an information system. *Source*: adapted from Bemelmans, 1991, p. 245.

Functional Requirements. Before an information system can be developed or a software package can be selected, it is necessary to know which requirements the system should meet. Next to the possible requirements put upon the supplier of a packaged software solution, the development process, et cetera, system requirements can be subdivided into *logical* requirements (again subdivided into so called functional and performance requirements) and *technical* requirements (i.e., related to the systems software and hardware) (Bemelmans, 1991, p. 147). *Functional* requirements define the functions of the system, i.e., what data should be processed, stored and provided. Functional requirements therefore address the data that should be accommodated by the system, and the type of processing that has to take place on these data to provide purchasing professionals with the required information. *Performance* requirements on the other hand define how — i.e., on which conditions — data processing, storage and provision have to take place (e.g., related to the speed, reliability, security and user friendliness of the system). Yet another restriction to the scope of the research concerns the requirements that can be put on information systems. The research project only considered the functional requirements that can be put upon information systems.

RESEARCH DESIGN

Research Approach

Design-Oriented Research. As can be concluded from this chapter so far, the research is not only focused on analyzing specific phenomena (viz., the currently existing IT applications in industrial purchasing). It primarily aims at the design of a set of design directives and reference models to make it possible to use a referential strategy in developing or selecting IT applications for purchasing. The research is therefore also primarily design oriented.[9]

Strategy. As was already identified earlier, there are several strategies for identifying information needs (see page 12). In developing the design directives and reference models, elements of several strategies were adopted. For example, existing systems and reference models were analyzed, users were interviewed, methods and techniques as advocated in the process and data oriented approach were applied, and prototypes were developed.

The PCI Paradigm. The approach that was taken in this research is based upon the method for designing reference models proposed by Greveling in his dissertation (1990, pp. 205-255). This method is strongly influenced by the work of Bemelmans (see, e.g., Bemelmans, 1991, p. 149-154). The central starting point in that approach is the viewpoint that it is necessary for the development of functional requirements to first investigate the decisions and the characteristics of the corresponding decision making processes that have to be supported (Bemelmans, 1991, p. 26, 149-154).

[9] Two types of (scientific) research approaches can be identified in the methodological literature, namely, the theory-developing or analytic research approach and the design-oriented or applied research approach (see, e.g., Van der Zwaan, 1990, pp. 29-53). The differences between the design-oriented and theory-developing approaches are not so much to be found in the structure and the methods they apply, but rather in the purpose of the research and the techniques that are used. Theory-developing research focuses on describing, explaining and predicting phenomena, whereas design-oriented research focuses on the models, instruments, methods, directives and procedures needed to influence and actually change phenomena.

The foregoing can be illustrated by making use of the control paradigm described by Bemelmans (1991, p. 29). The information system can be positioned in the control paradigm as depicted below.

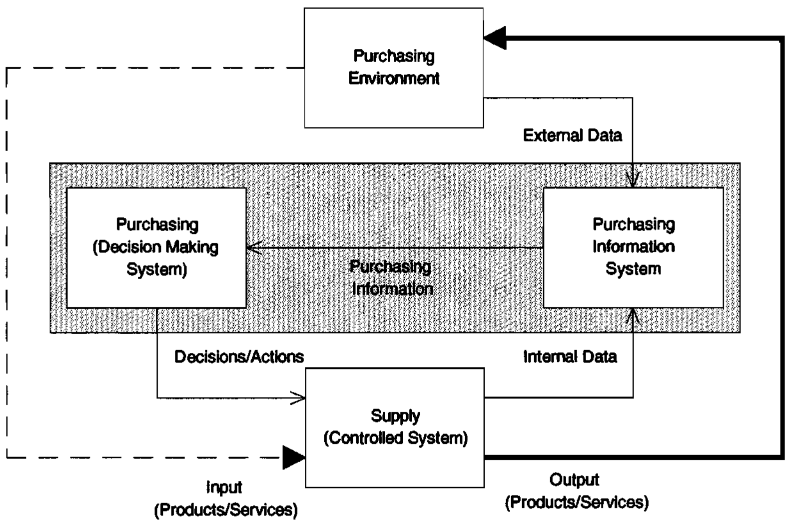


FIGURE 1-3. A somewhat simplified representation of the place of an information system in the control paradigm. *Source*: adapted from Bemelmans, 1991, p. 29.

The figure above illustrates that the information system has the function of recording, storing and processing relevant (internal and external) data into administrative information useful in purchasing decision making. The foregoing approach of Bemelmans is referred to as the PCI paradigm. In this paradigm the information system (I) is said to be dependent on the decision making processes to control (C) the primary processes (P) (see Figure 1-4). Put in another way: the functional requirements are derivable from the various decisions involved in the decision making system, the decision making situations that can be come across, and the corresponding decision making process.

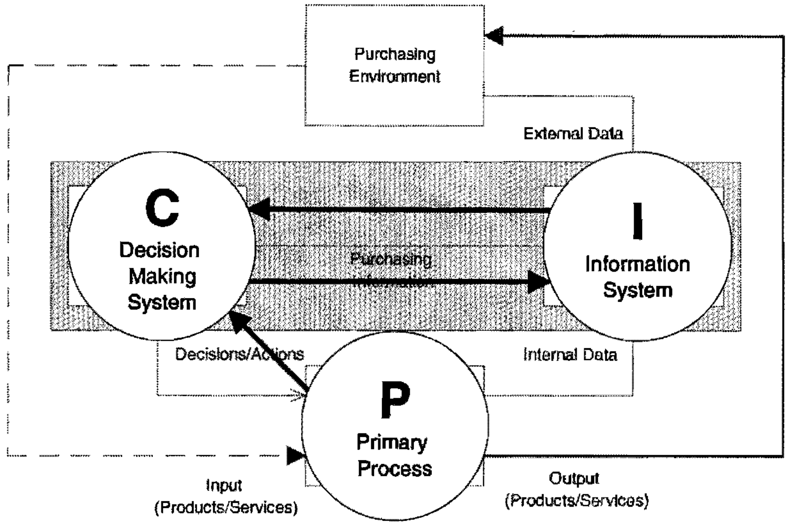


FIGURE 1-4. The PCI and control paradigm. *Source*: adapted from Bemelmans (1991, p. 29 and p. 151).[10]

Research Method

The research was subdivided in the following three phases, viz., (1) preliminary research, (2) analysis, and (3) design.

Preliminary Research. To first gain insights in the field of research, some preliminary research activities were carried out. A first desk research study took place into contemporary industrial purchasing and its management that focused on the problems, issues and challenges of the use of IT in industrial purchasing. Parallel to this desk research study, research was carried out at the purchasing departments of four different industrial

[10] The arrow of the information system (I) towards the control system (C), i.e., the decision making processes in place to control the primary processes (P) in this figure indicates the enhanced possibilities the information system can provide the decision making function in an organization. Information technology in this way can also be seen as an 'enabling' technology in organizations as was also argued by Hammer and Champy (1993). In this dissertation therefore, the potential application and possible benefits of new emerging IT possibilities in industrial purchasing were also considered.

companies.[11] This preliminary research phase mainly aimed at improving the definition of the problem statement as well as the research design. Moreover, this research phase focused on gaining some initial understanding of the content of industrial purchasing, the diversity of activities within it, the state of the art in the application of IT in industry, and new requirements.

The remainder of the research was phased according to the posed research questions. This implies that the first phase dealt mainly with the analysis the current state-of-the art in IT in industrial purchasing. Considering this analysis phase, improvement areas as well as challenges for new application areas of IT in industrial purchasing were identified. This introduces the second and most important part of the research, viz., the development and design of reference models illustrative of the way IT functionality can be supportive to purchasing decision making and the management of these decision making processes. Clearly the research consequently consisted of two phases; that of analysis and design.

Analysis. The analysis phase primarily dealt with answering the first three research questions posed on page 13, viz., (1) what is the current *state-of-the-art* in IT for industrial purchasing (including any already existing reference models), (2) what is the *coverage* of this IT in terms of the support it provides for contemporary industrial purchasing, and (3) what are the main *reasons* for this state of affairs concerning the application of IT in industrial purchasing? In this research phase insight was gained in the historical developments in, and current use of IT in industrial purchasing. This was done through an extensive and thorough desk research study focusing on answering the first three research questions. Furthermore, by analyzing some of the systems in use as well as analyzing the documentation of automated purchasing information systems (from both commercially available standard software packages and organization specific IT developments), these systems were described and characterized concerning their functionality. The case studies that were carried out in the first phase thereby served as a (practical and useful) guide in interpreting the analysis results gained in theory.

Design. The design phase focused on answering the remaining research questions, viz., (1) what *purchasing* decisions are involved in contemporary industrial purchasing, and subsequently (2) what typical

[11] The companies that were involved in this preliminary stage were ASM Lithography (a manufacturer of high tech, capital-intensive wafer steppers in small series), DAF Trucks (a truck manufacturer), Philips Electronics and Akzo-Nobel Chemicals.

decision making *situations* can be identified in contemporary industrial purchasing, (3) *how* are decisions made in the various typical purchasing decision making situations, (4) *how* are the various identified purchasing decisions reached, and (5) how are the purchasing decision making processes *managed*? In the design part of this research, the following activities were carried out to answer these questions in successive levels of detail:

1. *Detailing of Purchasing Activities.* Based upon a case study[12] in an industrial environment, the various purchasing activities and decisions were identified and described. In this description, the interfaces between purchasing and other organizational functions, in particular product development and logistics, were also described.
2. *Development of a Typology of Purchasing Situations.* Following desk research, a typology of purchasing situations in industry was developed based upon an extensive case study.[13]

Based upon these first two activities several initial design directives and IT possibilities could be defined that were used in the next stage of the research.

3. *Evaluation of Design Directives and Reference Models.* By adopting a prototyping approach for some purchasing decisions the corresponding processes as well as decision making practices were described in typical purchasing situations. These detailed descriptions formed the basis for the functional specifications of a supportive purchasing information system of which prototypes were developed.[14] These prototypes were subsequently used for evaluating the design directives and models used in developing the prototypes.

In the final phase of the research the results of the previous steps were summarized and brought together in reference models and design directives. These were subsequently used in a project aimed at the improvement of an

[12] This case study was carried out at Philips Medical Systems.

[13] This case study was carried out at NAM (a Royal Dutch/Shell Operating Company).

[14] These case studies were conducted at Fokker Aircraft for the development of IT functionality for contracting and contract administration, and at Philips Medical Systems where IT functionality was developed for support of specification, market research, supplier selection and qualification activities.

actual software package.[15] This yielded additional insights in the practicability of the research results.

The method outlined in this section is summarized in Figure 1-5.

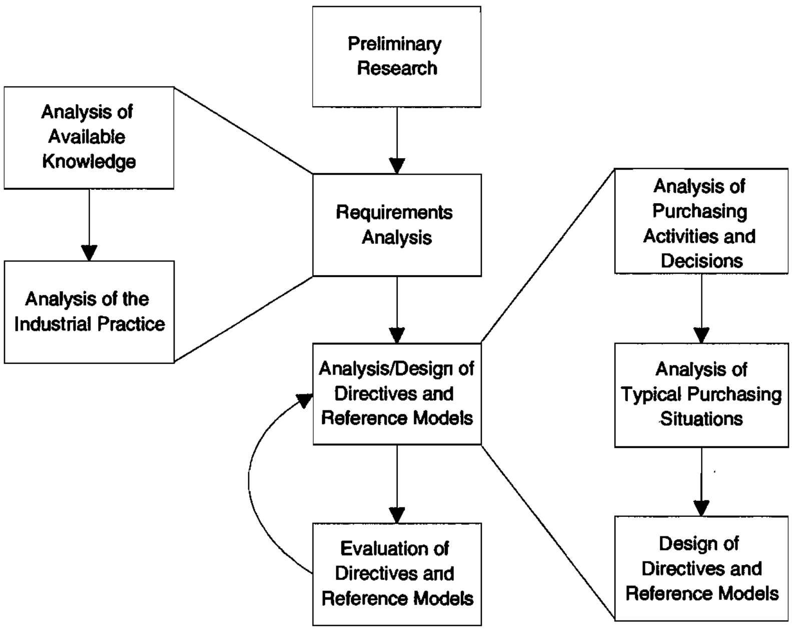


FIGURE 1-5. The research method.

Throughout the research, the newly developed ideas and concepts were evaluated by means of several workshops involving several 'experts' like senior buyers, purchasing managers, and purchasing staff members of those companies that made advanced use of IT in purchasing or who recognized the needed improvements ahead of other users. Management consultants, IT specialists, and academics were also represented.[16]

[15] In this phase, a project was carried out at *Baa*N Development (a major ERP software vendor), aimed at the improvement of the purchasing functionality in the Distribution module of their software package *Baa*N V.

[16] Companies and institutes represented in these workshops were Akzo-Nobel, Andersen Consulting, ASM Lithography, the *Baa*N Company, Bakkenist Management Consultants, BSO/Origin, Coopers & Lybrand Management Consultants, DAF Trucks, Nestle/Douwe Egberts, the Dutch Association of Purchasing Management (NEVI), the Eindhoven University of Technology, ENCI Nederland, Fokker Aircraft, Hero Nederland, KPMG

The Role of Case Studies

In the research, extensive use of case studies was made. In the *analysis* phase, case studies were mostly used in an exploratory and descriptive fashion, aiming at focusing the research by describing purchasing practices and listing the IT requirements stemming from these practices. As was also argued by Van der Zwaan (1990, p. 67), case studies are very suitable in this initial research phase because of the relative newness of and unfamiliarity with the subject. Furthermore, Yin also argues that case studies are favored when contemporary events are examined and when there is only little or no control over the events being examined. (Yin, 1989, p. 20). In this research phase this is also the case, as our 'snapshots' only focus on the description and analysis of contemporary events and situations without interfering with them. Besides, the case studies in the analysis phase also enabled a more specific definition of the central notions in this dissertation. Another advantage of using case studies was the possibility to investigate the use of information technology in purchasing in a real-life context.

The use of case studies in the *design* oriented part of the research served two main purposes. First, they served as the means for detailing the encountered purchasing practices and for developing an initial set of design rules. In this way, the case studies were used for deepening the available knowledge on the subject and for proposing a first set of 'theories'; the design rules. This function of case studies was also described by Van der Zwaan when he discussed what he calls the 'unfolding' of theories by using case studies (Van der Zwaan, 1990, p. 68, 71). Yin and De Leeuw also indicate this function of case studies (see Yin, 1989, p.18 and De Leeuw, 1993, p. 131). Second, the case studies focused on the evaluation — or 'testing' as Van der Zwaan calls it (p. 71) — of the proposed design rules on their practicability and usefulness. This was done by building prototype systems based upon the proposed design rules, and by subsequently evaluating these prototype systems (and thus implicitly the proposed design rules). This was done by the company for which the prototype was developed. Furthermore, the persons involved in the already mentioned workshops evaluated the prototypes and their underlying directives in order to assess their applicability in other situations than the situation for which they were originally developed.

Management Consulting, Lucent Technologies, NAM, NedCar, Océ Nederland, Philips Electronics, Stork Industries, Twente University, and Vanderlande Industries.

ORGANIZATION OF THE DISSERTATION

This dissertation is organized according to the research steps identified in the previous section (see Figure 1-6, in which also the most important case studies that were carried out are positioned). These are organized in the three parts that constitute this dissertation: analysis (Chapters 2 through 4), design (Chapters 5 through 7) and evaluation (Chapter 8 through 10).

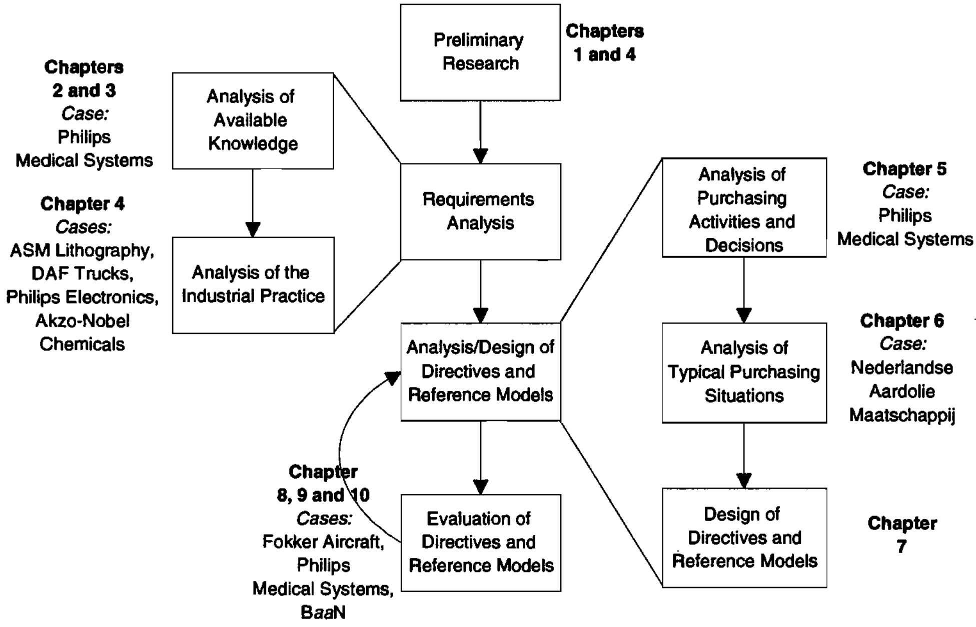


FIGURE 1-6. The organization of this dissertation.

Analysis. Chapter 2 starts of with a thorough historical review of the use of IT in purchasing. Chapter 3 then goes deeper into the purchasing functionality of standard software packages and reviews some existing reference models. Chapter 4 then takes the plunge into the practice of IT in industrial purchasing. Based upon the investigated state-of-the-art and four preliminary and explorative case studies, this chapter derives new requirements for information technology supportive to the contemporary purchasing function.

Design. Chapter 5 is the first of the design oriented chapters in this dissertation and focuses on the purchasing activities and decisions that are carried out in industry. The requirements stemming from the analysis phase were thereby taken into account. It provides a thorough insight in the objectives, functions, and main decisions that can be encountered in contemporary industrial purchasing. Chapter 6 then proceeds with presenting a differentiated view on industrial purchasing based upon contingency theories. It provides a typology of purchasing decision making situations that is illustrated with a case study. Chapters 5 and 6 then result in the initial design principles regarding the use of IT in purchasing. These are reported in Chapter 7.

Evaluation. Chapters 8 and 9 further detail and illustrate the results from Chapters 5 and 6, but primarily deal with applying and evaluating the proposed design directives. These chapters describe two prototype systems that were developed in the course of the research and their detailed designs. The results from their evaluation are also included in these chapters. Chapter 10 concludes the research by discussing the research results (i.e., the conclusions corresponding design directives) and their use in practice. It contains the major conclusions and implications, and it identifies areas for further research. Furthermore, Chapter 10 presents some considerations regarding the research project as a whole.

SUMMARY

In this chapter we outlined the topic of this dissertation: information technology in purchasing. As purchasing has undergone significant changes over the last few decades, it was argued that the IT tools used to support purchasing will need to be enhanced. The challenge of this research therefore is to increase the currently existing knowledge on the effective use of IT in contemporary industrial purchasing. The focus thereby is on the application of IT directed at the improvement of the effectiveness of the purchasing function. The main research question derived from the foregoing was what IT functionality should and can be applied to effectively support contemporary industrial purchasing. Furthermore, the scope, design and method of the research were clarified.

ANALYSIS

—2

An Overview of Information Technology in Purchasing

"Our investigations have made it clear to us that companies that are able to master and adopt state-of-the-art information and telecommunications technology will have the future. .... In this way we see this factor not per se as the driver of gaining more professionalism in purchasing and supply management; rather, *it is the enabler without which advancement in this area will not be possible.* As investments in this area only pay off only some time after they were made, we expect that the future winners are already known at this time. This of course also holds true for the losers. These will be the companies which have invested only marginally in this topic. For these companies it will be difficult to catch up" (*Source*: Van Weele and Rozemeijer, 1996, p. 116, italics added).

CHAPTER CONTENTS

As in any research, it is senseless to 're-invent the wheel' and therefore this chapter primarily deals with answering the first research question of this study, i.e., what is the current *state of the art* in IT for industrial purchasing. In this chapter therefore the historical developments in, and current use of IT in industrial purchasing are reported. This was done through an extensive and thorough bibliographic study covering the most important literature of last three decades. After summarizing the developments, this chapter also goes into the reasons for the state of affairs. This chapter therefore also answers the second and third research question of this research.

A HISTORICAL OVERVIEW

The Sixties — Automation of Clerical Work

The first literature on the use of information technology in purchasing appeared in the sixties.[1] This literature stressed that although the significance of purchasing for business was apparent, "it seemed to be a stepchild when it came to EDP applications". The most important potential of information technology was considered to be in taking over "the buyer's routine work, perform it faster and more accurately and leave him free for complex decision making and other creative activities. .... The computer can maintain and present records faster and more completely than any economical manual system could" (Widing and Diamond, 1964, pp. 111, 113). Two years later, the conclusion that purchasing was "the last function in the business world to be assimilated into the computer universe" was again confirmed (Kollios and Stempel, 1966, p. 10). In 1967 a more sophisticated use of information technology was reported: a vendor evaluation system based upon closed order information (Cantor and Loda, 1967, p. 71). Most of the applications in the sixties suggest that "the primary use of the computer is in the automation of routine and/or voluminous data gathering and manipulation tasks". A study in 1968 (Lindgren, 1968) also concluded that "purchasing departments have first automated purchasing functions that were clerical and related to high volume paper flows" (p. 168). The respondents in this study claimed their benefits to be increased speed, error reduction, cost reduction and a reduction of their clerical workload. A 1969 survey (Davis and Tasso, 1969, pp. 32-40) verified these results. This survey also found that there were three primary advantages of EDP in purchasing: (1) the ability to handle large volumes of data without adding personnel, (2) a reduction of manual effort, and (3) economically feasible report generation. A more detailed study in that year (Timbers, 1970, pp. 45-64) showed that the areas then being computerized were (in this order): maintaining purchase history records; collection of purchase usage data; maintenance of vendor price and address files; matching purchase order, receiving, and invoicing data; providing expediting information to buyers; and inventory control.

From the literature in the sixties clearly perceives the purchasing function as lagging behind other organizational functions in its assimilation

[1] To a large extent this section as well as the incorporated references were adopted from an article of D. Larry Moore and Harold E. Fearon in 1973 (Moore and Fearon, 1973a). Therefore, if not indicated specifically otherwise, the quoted text is taken from this article.

to computers. If computers were used, they were merely deployed for clerical and routine activities involving high volume paper flows. The systems were deployed primarily to reduce purchasing's clerical workload,[2] to increase the processing speed, and to reduce clerical errors. The main objective of the first (transaction processing) systems that appeared in purchasing was clearly to support the execution of operational purchasing activities in fairly routine (repetitive) situations.

The Seventies — Reporting and Integration

One of the major contributions in the area of automated information systems in purchasing in the early seventies was by Moore and Fearon. In a study on the use of transaction processing and reporting systems carried out in 1972 (Moore and Fearon, 1973a, pp. 13-39) they report that transaction processing systems (or as they call it: computer operating systems) "are the first to be implemented in purchasing" (p. 26). The majority of systems found in their study are of this nature. They argue that this is the fact due to the economical impact of this type of systems via the reduction of clerical staff. Greater accuracy and turnaround effectiveness are said to be additional justifying factors. Applications that were found in more than 50% of the cases were systems supportive to (in descending order): (1) reporting receiving status, (2) scheduling and expediting, (3) reporting open purchase orders, (4) expenditure reporting (per commodity and supplier), and (5) tracking price and source history. In a subsequent article (1973b, pp. 2-25), Moore and Fearon investigated the use of computer-assisted decision-making in purchasing. From their literature review they conclude "that it is evident that its application is in its infancy" (p. 11). They continue by describing nine applications found in some of the firms that were perceived as being on the leading edge of computer application in those days. Although these applications were very promising, they were still in an experimental stage and only used by some of the 'best in class' companies of those days. Therefore, Moore and Fearon concluded that purchasing still was "seriously underutilizing the computer as an analytical tool" and that "the ability to utilize this development [of computer-technology] ... is lagging behind the equipment" (p. 25). In a concluding article of Moore and Fearon published in 1974 (Moore and Fearon, 1974, pp. 30-39) the authors explore the reasons for

[2] Although computers are mostly introduced to reduce the efforts related to clerical duties, it is, however, not uncommon to find that after the implementation of IT in a working environment clerical input duties require more effort than before.

their earlier findings. The reasons were found to be (1) the existence of many clerical functions within purchasing causing the initial focus to be on cost reduction and elimination of personnel, (2) the perception that the initial automation within purchasing often was forced upon the purchasing department, and (3) a lack of resources committed to purchasing which was said to be related to top management's view of the purchasing function.

In an experiment Senn and Dickson (1974, pp. 52-64) investigated the use of computers in presenting data as a means of supporting decision making in purchasing. Their results indicated that using a computer instead of hardcopy reports did not significantly improve the decision effectiveness of users. The efficiency with which these decisions were reached, however, did significantly increase when a computer was used (in terms of the amount of information requested and the time used to reach a decision). Considering their research results, they concluded that on-line decision making support required and deserved further study.

One of the major causes of the fact that IT did not penetrate into decision making in purchasing, mentioned by Shaughnessy (1975, pp. 22-29), was the unstructuredness and uniqueness of many supply related problems such as make or buy, contract negotiations, etc. He did, however, state that "many of the problems of the supply executive may be supported and complemented by information systems" (p. 25). He also stated that "a company that has computerized the purchasing, inventory or accounts payable operation is in a position to make secondary use of this data for purchasing planning and control" (p. 25), indicating the use (or 'elevation') of consolidated operational data from transaction processing systems in reporting systems supportive to management decisions. Shaughnessy calls this "the vertical integration of transaction data" (p. 25).[3] Another important concept that has added value compared to single-purpose computer applications is that of "horizontal integration of applications" (p. 25) mostly seen in the MRP software that became widely accepted in those days.[4] In this integration, however, purchasing is most often only seen as being at "the back-end (execution)" part of the system (Hall and Vollmann, 1978, p. 107) (see Figure 1-1).

[3] Examples of the use of consolidated operational data in purchasing can be found in Data Communications User (1974), Berlet (1974), Nessim (1975) and Boyd, *et al.* (1975).

[4] Examples in this decade of this horizontal integration (primarily) with materials management systems, but also with systems supportive to accounting or design departments can be found in Birmingham (1972), Harris, *et al.* (1976), Office (1978), Hall, *et al.* (1978), Huber (1979) and Moran (1979).

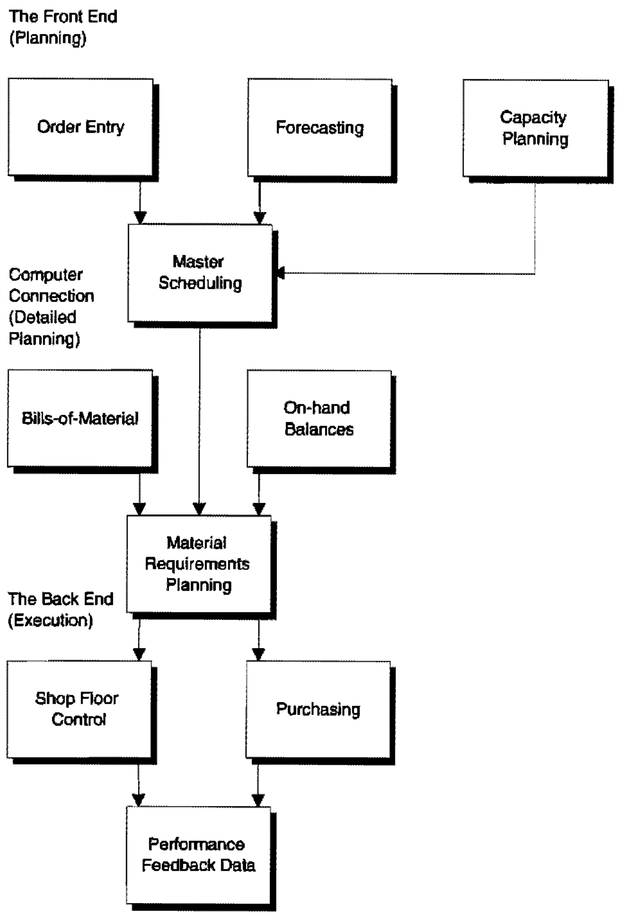


FIGURE 2-1. Concept of a Material Requirements Planning (MRP) system. *Source*: Hall and Vollmann, 1978, p. 107.

Shaughnessy concludes by stating that "in the years to come the competitive edge in materials management might well be related to information supported techniques" (p. 29). Another major threshold in using computers in purchasing decision making, identified by Lyons (1979), was the limited knowledge of purchasing managers and personnel of the possibilities and development of information systems (p. 19).

In these years the type of computer applications in purchasing did not change significantly. However, as Cone (1978) reported, the new computer environment that was rapidly embracing organizations, "brought the computer and buyer, particularly in large organizations, into intimate contact with each other" (p. 2). Besides the efficiency improvements in transaction processing that traditionally were identified as being the main advantages of using IT in purchasing, Cone also found that the accessibility of essential information denoted a significant benefit of using data bases in purchasing (p. 3).[5] Cone also identified several roles a computer might take (p. 4): (1) a *communicator*, enabling message sending between users in various departments, (2) a *clerical helper* in preparing and printing documents, (3) an *information center*, enabling consolidation of operational data as well as providing access to traditionally 'hidden' information, (4) a *monitor* of open orders, supportive to expediting, and (5) a *notebook*, enabling users to enter notes about orders.

Summarized, during the seventies it was clear that information systems could be deployed not only to support the execution of operational purchasing activities and producing related documents such as purchase orders, but could also be used for reporting (and eventually even supporting decision making). At first, this reporting functionality was used to monitor the operational purchase process (i.e., by producing reports on open purchase orders, receiving status, etc.) which improved the ability to effectively expedite. Second, this type of functionality was used in producing summaries of consolidated operational data as well as reporting historic trends that could be used for more (unstructured and unique) tactical decision making in purchasing. Other uses of the computer that appeared on the scene at the end of the seventies were the use of the computer to efficiently answer ad hoc queries of purchasing managers, to communicate about the status of the purchasing process, and to (accessibly) record notes on specific purchase orders. The major area of computer application in the seventies however, still was in transaction processing for the rapid and accurate manipulation of repetitive data aimed at taking over the buyer's clerical and administrative chores (reduction of paperwork, automatic numbering of purchase orders, reduction of order preparation and writing time, etc.).

[5] An example of such an application can be found in Katzel (1976). Katzel describes a system that is used for retrieval of information in the enormous amount of magazines of technical or reference nature. The system is based upon group technology principles. Beyond efficiency, the system was also good public relations and it improved customer service.

The Eighties — Analytical Support and Communication

In the early eighties, Parasuraman (1981, pp. 10-14) conducted an empirical study in the USA on the use of computers in purchasing. In his study, only 53% of the respondents indicated that their purchasing departments did utilize computers in some aspect of their operations. Purchasing tasks for which a computer was used were — in decreasing order — (1) maintaining inventory records (80%), (2) maintaining a list of vendors (58%), (3) filing and monitoring status of purchase requisitions and orders (46%), (4) keeping track of vendor ratings (21%),[6] and (5) materials requirements planning (14%) (p. 12). The top three were classified as being "fairly routine" (p. 12).[7,8] The computer apparently was being used "very sparingly for planning oriented activities such as materials requirements planning, and evaluation and selection of vendors" (p. 13). He concludes with stating that "the increasing capabilities and decreasing costs of computers, along with the potential for improving purchasing productivity through computerization, should provide an impetus for purchasing professionals to consider expanding the role played by computers in their operations" (p. 14).

In the summer of 1981, Shore stated that "purchasing decision makers often require more data — in a convenient format — than has been made available tot them" (p. 8). He also states that "MRP has emerged as the backbone of many manufacturing organizations", but also that "it has not proven to be a useful tool in managing the purchasing process" (p. 12). Factors that explain this observation were said to be, that (1) it has not always been clear what information purchasing decision makers require, (2) computer systems typically address situations in which a magnitude of data must be processed (such as inventory and manufacturing control), (3) the perceived payoff and hence the priority for developing such systems has been low, (4) it is unlikely that one general purpose purchasing information system can be developed, and (5) the cost of developing these systems has

[6] An example of a vendor quality management information system in the eighties can be found in Pelter (1985).

[7] A similar picture was found in the Netherlands, as reported in Platford (1986). Reasons that Platford identifies to contribute to this picture were the lack of IT knowledge in purchasing, the low status of purchasing, the low educational level of purchasing professionals and the importance put upon the 'relational' aspects of the profession.

[8] Examples of this type of more widespread routine use of computers in purchasing in the eighties can be found abundantly, e.g., in Rokovich and Hess (1980), Nowading, (1980), Modern Materials Handling (1983), Faes (1986), Nijssen (1986), Schneider, *et al.* (1987) and Handley (1988).

been prohibitive for all but the largest companies (pp. 8-9). The growing knowledge on information systems for purchasing, the experience with information systems in other areas as well as the decreasing cost of computer systems, however, made the development of a purchasing information system feasible.[9] Shore then continues with sketching a dedicated purchasing information system containing data on (1) vendor and materials, (2) outstanding quotes, (3) vendor delivery performance, (4) lead-times of vendors and materials, (5) vendor turnover, (6) vendor quality performance and (7) outstanding orders. Such a system should strive "to improve the decision making process by providing timely availability of the most useful information required by the decision maker" (p. 10).[10]

Pinkerton (1986, pp. 185-228) provides the reader with a detailed and extensive overview of the typical automated purchasing information systems of those days. According to Pinkerton, the functions that a purchasing system should address are to: accept purchase requisitions, provide data for source selection, generate requests for quotation, analyze quotations, convert requisitions into purchase orders, print purchase orders, provide data for expediting the order, allow the buyer to change or amend the order, allow receipts to be posted against the order, match invoices with receipts, store purchase order history, and to provide various (user-defined) reports.[11] He also recognizes the backlog that purchasing has at that moment compared to other functional areas. Reasons that he mentions for this are (1) the difficulty

[9] Although Shore perceives a growing body of knowledge on information systems for purchasing, a 1984 study published in 1988 (Rowe, 1988) revealed that purchasing managers were exposed to IT the least of all functional managers that were taken into account in the study (e.g., marketing, finance/accounting, computer systems/engineering, operations, personnel and legal).

[10] Illustrative of the developments in applying IT in analytical purchasing decision making are articles by Bender, *et al.* (1985) and Ronen, *et al.* (1988). The first article provides an overview of IBM's Vendor Selection System (VSS) which was based upon a mixed integer optimization technique. Ronen, *et al.* give a detailed example of a operations research based decision support system for supplier selection and order scheduling in large projects. The application of IT for the purpose of aiding decision makers was also identified in other areas than just industry. Eldin (1983, pp. 53-60) reported on the Acquisition Management Information System (AMIS) that was in use by the United States Air Force (USAF). AMIS was a system initially intended to record and administer the large amount of documentation related to government contracts in use by the USAF. It therefore especially simplified the jobs of procurement clerks. However, it was also recognized that the data on contracts, supply or services line items, delivery schedules, financial status and contract performance were an outstanding source of information for decision making on various management echelons.

[11] An interesting use of reports for operational purchasing performance monitoring can be found in Henshaw (1987).

of specifying a system for purchasing because of the unstructuredness of purchasing decisions, (2) the lack of possible headcount reductions in the already relatively small purchasing departments, and (3), the lack of a common ground of purchasing and systems professionals obstructing the development of purchasing information systems. Pinkerton continues by stating that the benefits of a purchasing information system come from being able to do more, faster and more accurate analytical work. Examples of analytical work he mentions are: supplier performance, supplier/component quality results, cash commitments, buyer performance, material price variance, expenditure analysis (by commodity, supplier, totals, etc.), cost breakdown analysis, cost analysis supporting make-or-buy questions and quotation analysis.

The developments in logistics, especially the rapid adoption of the 'just-in-time' production principle, also contributed to the developments in the use of IT in purchasing such as the use of communication technology, networks, integrated data bases and automatic identification (e.g., bar-coding and Optical Character Recognition — OCR) (Yoo, 1989, pp. 117-126). As JIT depends heavily on high quality of purchased materials, purchasing practices shifted from short term and price based product buying and ordering, to longer term supplier contracting, quality partnerships with a reduced number of suppliers, and phased ordering in smaller lot sizes. Therefore, the monitoring, evaluation and certification of suppliers was growing in importance in a JIT environment. This gave rise to the use of IT for purchasing activities such as supplier selection, performance measurement, supplier evaluation, and supplier certification (Malley and Ray, 1988, p. 66-70). The introduction of JIT principles, together with the far reaching cooperation between supplier and customer, also induced changes on the operational level. Information technology was applied to link the operations of the customer and supplier by way of Electronic Data Interchange (EDI) (see, e.g., Platford, 1986, pp. 4-7). EDI is usually defined as the direct computer-to-computer exchange of business information in a standard format (directly, or possibly via an intermediate information broker or Value Added Network — VAN) between parties that are involved in business transactions (see, e.g., Monczka and Carter, 1987, p. 3; Hofman, 1994, p. 106). The primary use of EDI was in the accurate and timely transmission of purchase orders, change orders, acknowledgments and advance shipping notes. In this way EDI enabled the interorganizational use of the Kanban, the instrument used to implement the 'pull' philosophy of the

JIT system.[12] Another new and very sophisticated use of communication technology that was reported by Dubois, *et al.* (1989) was in the transmission of design data like 2D CAD drawings and 3D CAD models, etc. Later, this became known as PDI — Product Data Interchange. A very important side effect of the use of IT in interorganizational communication was that it also increased switching costs and — in that way — influenced market structures (Dubois, *et al.*, 1989).

The emergence of the new applications of IT in purchasing, in particular in activities such as supplier selection and qualification, also gave rise to the need of the availability and administration of more external instead of internal data. Suppliers and branch organizations took this opportunity to market their organization and branch of industry by providing this data in digital form.[13] Several other examples of external data bases (like Euronet Diane, MAGIC, Fintel, Fine Chemicals, Newsline, Codus and Prestel) can be found in Baily and Farmer (1985, pp. 279-280). Besides the use of more traditional IT, the appearance of new technologies like Videotex also changed the nature of some of the sources of relevant purchasing data.[14]

As we can conclude from the foregoing, the application of IT in purchasing during the eighties further developed itself in the direction of management reporting and support of analytical work for use in more unstructured purchasing tasks. The rapid adoption of JIT by industrial companies has also had a profound impact on the application of IT, in particular in the use of traditional IT in supplier selection and management, and the application of new technologies in communication and automatic identification. A last development that can be mentioned is the use of new technologies in the provision of (external) data, such as external data bases and videotex. Although the foregoing opportunities were clearly recognized, the actual implementation of these new applications seriously lagged behind the expectations. It is remarkable that most of the literature in the eighties still reports on the fact that "few ... have applied effectively this capability to purchasing", as Porter (1989, p. 12) notes in his article with the telling title 'Why purchasing can't get the systems it needs'. Van Eck (1989, pp. 26-33) —

[12] An illustration of these developments can be found in Lyons (1989). He describes the introduction of JIT and the accompanying systems at Gilette's Shaving Products Division.

[13] To give an example, at the end of the eighties the association for Dutch metal industry in the region of Twente (the VMT), e.g., supplied potential industrial customers a diskette containing supplier profiles and contact data that could be accessed using supplier name, operation type, product type or location.

[14] For example, November 1987, a 24 hour free Videotex service containing data on Dutch suppliers was put into use in the Netherlands (Schuchart, 1987, pp. 1-2).

in a very critical article — states that the main reason for this is, that purchasing cannot just be automated (especially not by IT professionals that only have a very limited perception of the content of the purchasing function). Van Eck states that purchasing needs to pro-actively identify the opportunities related to the use of IT in its tasks (and not only traditional IT), and apply these possibilities in newly designed purchasing processes that differentiate between various typical situations that can be encountered.

The Nineties — New Emerging Technologies

Buter (1990, pp. 28-33) provided a typical overview of the process of developing or selecting software for purchasing. The concept of the system perceived by Buter was further detailed in a report by Minkema (1992) and subsequently used by Van Weele (see Figure 1-2). This model of a purchasing system can be considered typical for the systems in use in the early nineties.

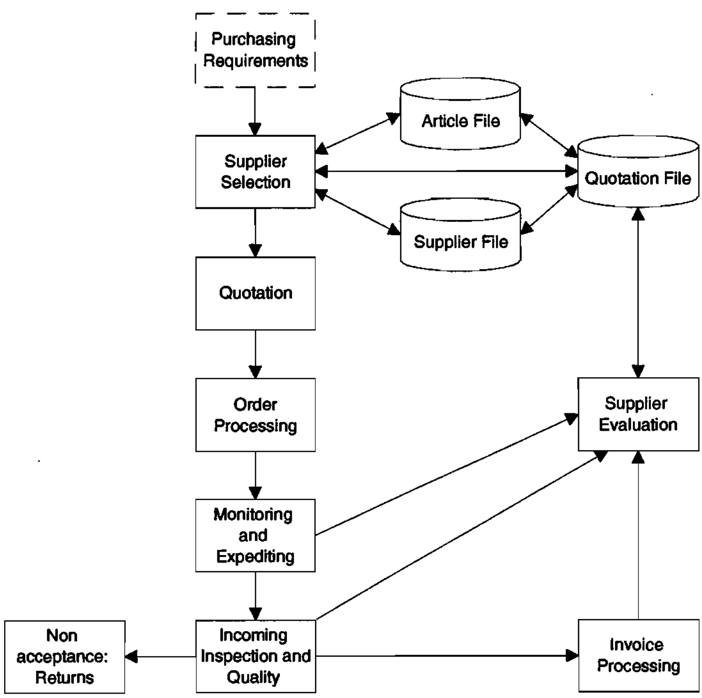


FIGURE 2-2. The concept of a purchasing system. *Source*: Van Weele, 1994, p. 175.

In 1992, Plank, *et al.* found that "extensive advances had been made in computer use by purchasing personnel and trends towards more sophisticated usage were obvious" (p. 243). The growth of inexpensive software and hardware made it possible even for small firms to computerize their purchasing processes. This resulted in a 98.2% computer usage rate amongst 107 respondents in their survey. However, purchasing activities addressed in the survey mainly involved administrative tasks such as maintaining vendor lists, inventory records and purchase order status, preparing purchase orders, correspondence and memos and operational planning activities such as MRP. When activities such as performance measurement and quotation management were addressed, the computer usage rate dropped to 44.7% resp. 14.5%.

A more interesting development in the use of IT in purchasing can be found in Cook (1992, pp. 20-27). In his article he explores the use of a relatively new technology that became widely available for business purposes, namely the expert system. Cook reports on a half-dozen applications of expert systems for use in purchasing. These involve applications for use in the assessment of the feasibility and planning of large military projects, sourcing decisions, item and supplier selection, and in prioritization of past due orders. France (1994, pp. 117-118) also reports on the use of an expert system, viz., for contract drafting at Nynex. The system is based upon a decision tree that includes hundreds of variations on the contract document being created. The system interacts with the user by means of asking simple questions to gather the factual data required to construct the contract. Another application of expert systems in purchasing was reported by Kolodziej (1994, p. 55). He reported on the ASAP (Approval System for Automated Procurement) of Lockheed Missiles and Space Company, Inc. This system — based on rules on company-specific policies and procedures — advises requesters of inconsistencies or rule violations and suggests appropriate alternatives. Recently, Vokurka, *et al.* (1996, pp. 106-127) described the design of an expert system for use in supplier evaluation and selection. A further (detailed) example of the use of an expert system in purchasing was the 'Wissensbasiertes EinkaufsBeratungsSystem' (WEBS), a prototype of a knowledge-based supplier selection system (Blumberg, 1991).

In the nineties, the use of EDI was further enhanced to not only transmit very operational data such as Kanbans, but also mid term material requirements such as supply schedules resulting from MRP runs. Kornelius *et al.* (1992, pp. 175-182) took this concept further when they introduced the concept of Multi-Level Supply Control (MLSC) that was further detailed in a dissertation by Kreuwels (1994). Carter and Ragatz (1991, pp. 19-23) further explored the use of bar codes and EDI in an effort to further improve the efficiency of operational purchasing processes, in particular in ordering and receiving. A new application of the emerging communication technology in the cooperation between buyer and supplier was reported by Southey and Smith (1995). The prototype system they described was aimed at "facilitating the passage and exchange of information [between car manufacturers and automotive component suppliers] in all stages of the design of a new vehicle" and consisted of "three major components: (1) video conferencing software and a shared whiteboard application, (2) a product library, and (3) a high speed data transfer capability."

The purchasing or procurement (credit) card is another initiative in applying technology in a purchasing environment. In the early nineties, more and more organizations became aware of the fact that they used the same procedures (and incurred the same processing costs) for both large and small purchases. Various large and international credit card organizations like MasterCard, Visa and AmEx entered this market and presented purchasing (credit) cards that could be used for small purchases without losing control (see, e.g., Bank Marketing, 1994, p. 7; Day, 1994, pp. 22-23). Control is ensured by assigning parameters to set authorities on, e.g., the number and expenditure of daily or monthly transactions and specific supplier/merchant categories. Moreover, no cash advances are allowed on the purchasing card. Most of the card associations also offer value-added services like customized electronic reporting on card use.[15]

Another new and very exciting application of IT in purchasing came with the emergence of the Internet, a global computer network which rapidly actualized the concept of an 'electronic marketplace', and the World-Wide Web, a system simplifying and speeding up searching for information on the Internet. The Internet gives companies the possibility to create an on-line presence (the 'virtual storefront'), giving potential customers access to products and services right from their desktops (Information Today, 1995, p. 34). Again, banks and credit card associations entered this new market and provide secure, real-time and on-line card authorization and payment processing. This service allows users around the world to start purchasing goods and services via the Internet using any major credit card. Launched in

[15] MasterCard uses a data base called 'Smart Data' to generate reports on card use, Visa offers a similar service to track data and generate year-end reports, and AmEx — that even has a consulting arm specifically for its purchasing card program — has a system called 'Purchase Power', which helps corporations analyze card use, negotiate volume discounts and track suppliers.

April 1993, Industry.net[16] is such an on-line service linking businesses to suppliers (Stern, 1995, p. 10). Industry.net provides several (free) services including new product announcements, the ability to 'visit' trade shows on-line and it provides interactivity (by e-mail) between customers and suppliers (see Figure 1-3).

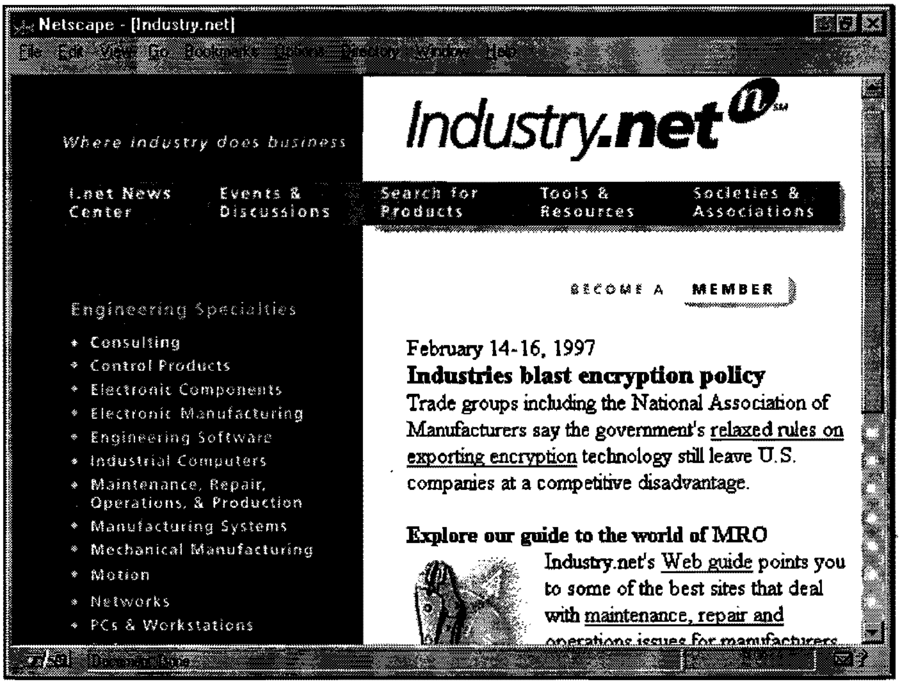


FIGURE 2-3. Industry.net.

Unlike other services on the Internet such as America Online (AOL) and CompuServe, which appeal to the masses, Industry.net targets purchasing agents, managers and procurers of services. Products marketed through Industry.net encompass complete factory automation systems, computers and printers, motors and controls, chemicals and raw materials. When it concerns buying software, it could even go further. Not only can software be purchased on-line, it can immediately be downloaded electronically (Brandel, 1995, p. 41). However, Brandel continues by saying that it is not a

[16] The Industry.net home page on the World-Wide Web can be found at "http://www.industry.net"

question of technology anymore, "it's a question of organization's processes catching up with technology" (p. 41).

Buyers can also make use of the Internet in another way, as described by Asker (1994, p. 58). Asker reports on the way NASA solicits bids via the Internet.[17] In this way the information on opportunities for contractors is quicker and more easily accessible, speeding up the contracting process. October 1994, President Clinton authorized NASA to test soliciting bids for mid-range procurement on the Internet (ranging from $25,000 to $500,000 annually, representing 80% of the agency's contract actions).[18] Asker continues by giving an outlook into the future at NASA involving possibilities for contractors to query NASA procurement systems on opportunities, providing links to detailed tender documents and possibilities to download the actual solicitations electronically.

As we can see, the nineties formed the scenery for many new and exciting applications of IT in purchasing. Most prominent and innovative developments that can be mentioned are the emergence of expert systems in purchasing, the use of the purchasing card for small purchases (together with the appearance of related value-added services such as customized management reporting) and the use of the Internet for electronic commerce. Next, communication and (multi-media) information technology also penetrated the field of supplier involvement in the product development process. Furthermore, the possibilities of EDI were further enhanced to be able to support long term visibility and multi-level supply control (MLSC) principles.

IT SUPPORT IN PURCHASING

Now that the historical developments in the application of IT in purchasing have been discussed in a detailed fashion, we turn to the typical support IT provides in the industrial practice. For although many different and advanced IT applications were identified in the previous section, most of the applications that may be found in practice usually are part of a commercially

[17] The NASA home page on the World-Wide Web can be found at "http://www.hq.nasa.gov/office/procurement"

[18] A fairly recent service making use of these kind of sites is provided by BidCast ("http://www.bidcast.com"). BidCast is an Internet-based business service designed to expand sales opportunities by forwarding bids directly to a company. BidCast searches government procurement databases and notifies companies of agencies actively seeking products or services. After bid notices are found, BidCast e-mails the information and contact person needed to participate in the bidding process.

available, integrated business application software package (nowadays mostly referred to as an Enterprise Resource Planning or ERP package.[19] An example of such a system — described in a case study during the research — is provided in the Industry Snapshot on the next two pages. The next chapter discusses the most important characteristics of these software packages in more detail. Because of the foregoing, the typical support that IT provides in practice does not match the discussed possibilities. IT support can thereby be defined in various ways. First, IT support might be interpreted as the extent to which information technology has penetrated the purchasing function. It can, however, also be interpreted as the extent to which specific activities that can be distinguished in a purchasing environment are supported by IT. These two topics are addressed below.

IT Penetration in Purchasing

Purchasing is making greater use of information technology. When putting several empirical studies in context, the following picture appears.

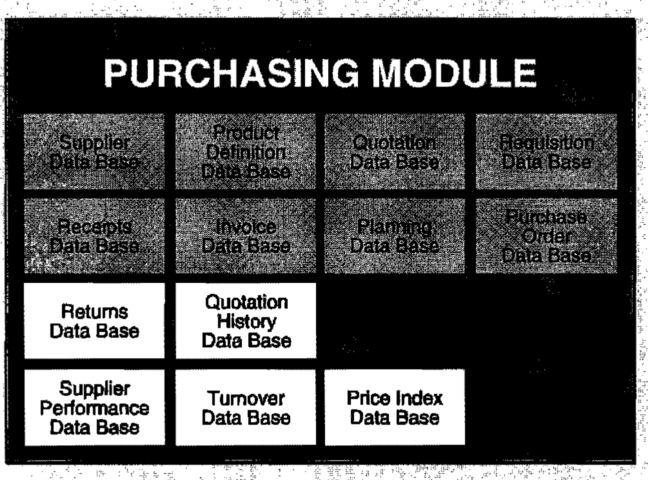
The 1981 study of Parasuraman found that 53% of a sample of purchasing employees used computers in some aspect of their purchasing activities (p. 12). A 1985 study by La Londe and Emmelhainz found an increase in computer usage by purchasing personnel (pp. 1-6). A 1987 study by Purchasing Magazine found that 88% of purchasing personnel used IT in some aspect of their work (pp. 16-17). A 1991 study by Bakkenist Management Consultants in the Netherlands found a computer usage rate of 79.8% (Roos, *et al.*, 1991, p. 11). The most recent empirical study by Plank, *et al.* in 1992 found a computer usage rate in purchasing of 98.2% (p. 246).

An important remark that can be made about the foregoing empirical results is that the computer usage rate in general increases with company size. In general, firms that use computers in their purchasing operations are likely to be larger (in terms of sales revenue, total number of employees, number of purchasing employees, and the number of product categories purchased) than non-users (see, e.g., Parasuraman, 1981, p. 13). Plank, *et al.* (1992, p. 146) also report that "larger companies are still the heavier users".

[19] This can be derived from a 1992 study by Heliview Marketingservice and Moret Ernst & Young Management Consultants involving over 400 Dutch companies. The results of this study showed that 67% of the companies already implemented such a system and that another 13% was in the process of selecting or implementing an ERP package. It also showed that more and more systems were selected out of commercially available packages instead of developed by the organizations themselves (74%) (Verstegen, 1992).

INDUSTRY SNAPSHOT 2-1. The Former COPICS System at Philips Medical Systems Nederland (PMSN)

Before Philips Medical Systems decided to buy *Baa*N's Triton in 1995, it used IBM's COPICS system. When Philips implemented COPICS in 1988, the original purchasing module was enhanced and renamed PRIM. Since it was implemented at PMSN, again several enhancements followed aiming at providing purchasing management with management information tailored to the PMSN environment. Finally, PRIM could be subdivided into the following data base parts containing data on: (1) suppliers, (2) product definitions, (3) quotations (and (4) quotation history), (5) planning, (6) requisitions, (7) purchase orders, (8) receipts, (9) invoices, (10) returns, (11) supplier performance, (12) turnover, and (13) price index.



1. *Supplier Data Base.* Besides basic supplier data this data base contained references to supplied items, general terms, contracts, purchase orders, requisitions, invoices, and returns.
2. *Product Definition Data Base.* This data base contained data on items, their structure, engineering changes and various product groupings. For MRP purposes, data was available on inventory levels at several locations and planned orders. Furthermore, requisitions and purchase orders for a specific item could be referenced. Also, data was available about the buyer responsible for a specific item. PMSN added a data segment on contracts for a class of items, e.g., in the case of a development contract when no product code exists.
3. *Quotation Data Base.* The Quotation Data Base mainly contained data on supplier quotes (and discounts and surcharges) and the suppliers' general terms. From this data base, it could be derived in which requisitions specific supplier quotes are suggested, and in which purchase orders these quotes or general terms are used. It was also possible to see which general terms were used in supplier quotes.

4. *Quotation History Data Base.* The Quotation History Data Base was added for performance reasons. It was a copy of a part of the Quotation Data Base.
5. *Planning Data Base.* In this part data was recorded used for MRP-runs. This involved data on gross requirements, planned orders and purchase schedules (call-offs).
6. *Requisition Data Base.* This data base contained data on requisitions for specific items. There were references to suggested suppliers or even quotations. Besides, there were references to the purchase orders and scheduled receipts related to the requisition. Also, the destination (i.e., internal departments) and the cost center was recorded.
7. *Purchase Order Data Base.* The Purchase Order Data Base contained basic data about purchase orders and lines, and call-off schedules. From this data base it could be derived which general terms and supplier quotes were used for a purchase order. Furthermore, it was possible to derive which requisitions originated the purchase order.
8. *Receipts Data Base.* In the Receipts Data Base the receipts of the scheduled call-offs were recorded together with the data on acceptance of the received goods.
9. *Invoice Data Base.* The Invoice Data Base contained data on invoices and their related scheduled receipts. Besides, data was recorded on cash and trade discounts, and additional charges.
10. *Returns Data Base.* The Returns Data Base was an addition of PMSN to the original PRIM module. It was a kind of invoice data base for suppliers of which goods were sent back. The Returns Data Base contained data on returns, their packaging and their original scheduled receipts. Besides, reference was made to the original supplier, the invoiced supplier, and the shipping address.
11. *Supplier Performance Data Base.* The Supplier Performance Data Base was also an addition to the original PRIM module. It contained calculated and aggregated performance data of specific suppliers on various levels (buyer, purchasing group, business unit and PMSN). The data was based upon, a.o., purchase orders and receipts data.
12. *Turnover Data Base.* The Turnover Data Base was also added by PMSN. It contained turnover data per supplier, per purchasing group and per product group based upon invoice lines. Like the Supplier Performance Data Base, it contains calculated and aggregated data.
13. *Price Index Data Base.* The Price Index Data Base was added by PMSN as a data base with the purpose of providing buyers with more decision support in their jobs. It contained data on the latest (invoiced) prices of suppliers of specific items, and the actual and budgeted turnover for an item.

Although all these empirical studies are based upon different research designs and different samples (in terms of the sizes of the samples as well as their composition), it is safe to conclude that over the last 25 years IT has almost fully penetrated the purchasing function. Therefore it is no longer a question *whether* to use IT in purchasing, but *how* to deploy it profitably.

Purchasing Support

When we take a closer look at the activities in which IT is predominantly used, we can identify activities such as maintaining inventory records, inventory control, maintaining vendor lists, preparing purchase orders, filing and monitoring the status of purchase requisitions and orders, preparing correspondence and memos, MRP and budgeting. When it comes to activities such as keeping supplier performance ratings, monitoring quotations and competitiveness, and selecting suppliers, usage rates drop dramatically (see Parasuraman, 1981, p. 12; Roos, *et al.*, 1991, p. 11; and Plank, *et al.*, 1992, p. 246). Scheuse (1994, pp. 52-54) in his study also claims that activities beyond the operational level were covered in only 10-20% of all cases. From these empirical studies it can be concluded that the typical use of IT in the purchasing practice is mainly limited to:

1. *Administrative Tasks*, like the registration of suppliers, items and — possibly — conditions (based on quotations);
2. *Requirements Identification*, i.e., systems mostly support the identification of (routine) time-phased requirements resulting from MRP runs, requirements resulting from inventory control, or (sometimes) manually entered purchase requisitions;
3. *Executive Operational Purchasing Activities* for processing the (mostly) routine requirements resulting from MRP runs, inventory control or purchase requisitions such as the recording of purchase orders, order confirmations, receipts, invoices, etc.; and
4. *Operational Control* such as order status monitoring, and invoice checking.

According to the already cited UK survey by CMG, 70% of the respondents felt that their needs were only adequately or even less met by the currently available support from IT mentioned above (Purchasing & Supply Management, 1995, p. 13).

REASONS FOR THE STATE OF AFFAIRS

Again, we address the issue raised earlier by Porter (1989) in his article with the telling title 'Why purchasing can't get the systems it needs'. From the historical survey several reasons can be found for the perceived arrears of purchasing in applying IT. These can be summarized as follows.

The Efficiency Focus of Early IT Applications. For long, the most important potential of information technology was considered to be in taking over the buyer's routine clerical work involving voluminous data gathering and manipulation tasks, and to perform it faster and more accurately than any economical manual system could. Computers therefore were deployed primarily in achieving efficiency improvements in purchasing so that the large volumes of data typically found in purchasing departments could be handled without adding personnel (or even by a reduced number of purchasing clerks). The reduction of clerical staff therefore is a historically grown justifying factor for IT investments. Greater accuracy and turnaround effectiveness were said to be additional justifying factors. The existence of many clerical functions within purchasing caused the initial focus of applying IT to be on cost reduction and elimination of personnel. However, because of the low (directly identifiable) potential savings in terms of headcount reductions in the already relatively small purchasing departments compared to reductions possible in other functional areas, it is still difficult for purchasing managers to justify the often huge investments in IT. For long therefore, the required investments in IT have been prohibitive for all but the largest companies to introduce IT in the purchasing function.

Purchasing's Perceived Added Value. Next to the fact of the relatively small purchasing departments, the insufficient insight in the added value of the purchasing function (which often resulted in a low status of purchasing for top management) also added to the difficulty of justifying investments in IT for purchasing. Top management therefore was more inclined to invest in other organizational functions such as marketing and logistics. As we already noted before, MRP has now emerged as the backbone of many manufacturing organizations, but it has not yet proven to be a very useful tool in purchasing. The fact that the impetuses for most of the IT applications typically found in purchasing have been initiated by adjacent areas other than purchasing (e.g., logistics and finance), has resulted in systems that are not adequate for purchasing activities except for some of the activities directly related to these adjacent business areas. This also explains the perception that IT within purchasing often was 'forced' upon the purchasing department.

Purchasing's Perceived Intrinsic Characteristics. Another major reason for the fact that IT has primarily been deployed in routine administrative tasks is the perceived unstructuredness and uniqueness of many other supply related tasks such as make or buy, supplier selection, contract negotiations, etc. Therefore it has not always been clear what information purchasing decision makers require in these tasks. Furthermore, it is also sometimes posed that it is unlikely that one general purpose purchasing information system can be developed considering all the different situations that can occur as well as the numerous personal styles in making these types of purchasing decisions.

A Lack of a Common Knowledge Base. The lack of a common ground of purchasing and IT professionals is also mentioned as one of the obstacles obstructing the development of information systems geared to the needs of purchasing. Due to a lack of education and training, purchasing managers are only marginally aware of the possibilities and opportunities of the use of IT within purchasing. Vice versa, software specialists and vendors often lack the detailed knowledge of contemporary purchasing practices and working methods required for developing effective IT tools.

For these foregoing reasons, purchasing is still a far cry away from actually applying the potential of currently existing IT to its advantage.

SUMMARY

This chapter attempted to answer the first three research questions, viz., what is the current *state of the art* in IT for industrial purchasing and what *support* does this IT provide to industrial purchasing, and what are the main *reasons* for the appeared state of affairs. Concerning the first two research questions, it showed that over the last three decades IT has almost fully penetrated purchasing departments in industry. The use of IT thereby evolved from automating the clerical and administrative chores of the buyer (in the sixties), to management reporting and integration with production planning (in the seventies), to decision support and communication (during the eighties). The nineties, finally, showed the emergence of many new technologies, the application of which in the purchasing environment is only at the beginning. It also showed that, although many advanced applications were reported in the literature, the typical use of IT in industrial practice is mostly limited to the application of standard ERP packages supporting administrative tasks, routine requirements identification, operational purchasing, and operational control. Reasons for this state of affairs were found to be the efficiency focus in applying IT, purchasing's perceived added value and process characteristics, and a lack of mutual understanding between purchasing and IT professionals.

—3

Standard Software for Purchasing

Some years ago a European manufacturer of branded food products took the initiative to implement an MRP system. The major objective underlying this initiative was to improve materials requirements planning: it should make materials planning, ordering and scheduling more reliable. Secondly, it should contribute to significant reductions in materials lead times. Finally, it should lead to better control of supplier performance. After some time had passed, materials requirements calculations were automated. The new system enabled materials planning on a weekly rather than a monthly basis. By exploding the bills of materials the production plans are converted into gross materials requirements expressed by materials codes. Balancing these requirements with existing inventories leads to the net materials requirements which then become the basis for requisitions sent by terminal to the purchasing department. Hard copy of this data is provided to the buyers and keyed into their stand-alone ordering system. Because of the many faults which occurred in copying information from one system to the other, the possibility was discussed with supplier of the MRP-I system of computerizing the ordering system as well, and to integrate this with the materials planning system (*Source*: Van Weele, 1994, p. 177).

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Cases like the one described in the introduction above are common nowadays. During this research alone, for example, *all but one* of the cooperating case study companies were already using a standard software package, and *all but one* purchased or seriously considered purchasing a new software package! This confirms the 1992 study by Heliview Marketing Service and Moret Ernst & Young Management Consultants. The results of their study showed that 67% of the 400 Dutch companies studied were using an ERP system and that another 13% was in the process of selecting or implementing an ERP package. The study also showed that more and more systems were selected out of commercially available packages (74%) instead of developed by the organizations themselves (Verstegen, 1992). Because of the importance of these ERP packages in present-day industry, this chapter discusses the most important characteristics of these systems from a purchasing perspective.

COMMERCIAL SOFTWARE PACKAGES

Over the last twenty years companies more and more turned to the use of standard software in their operations. A lack of IT specialists, the increased labor costs, the growing complexity of information systems, and the origination of the well known 'islands of automation' in organizations are a few of the developments that led to this phenomenon (Van Rijn, 1986, p. 18).

Advantages of Standard Software Packages

Implementing standard software packages has several advantages in comparison with a developing a bespoke system (Wortmann, 1984, p. 75; Van Rijn, 1986, pp. 19-20; Steele and Court, 1996, p. 208):

1. The *initial investment* required for purchasing or leasing a standard software package is far less than the initial investment required for developing a bespoke information system. The development costs of the software vendor can be spread over many users and there is no extensive need to call upon scarce and expensive IT specialists. As standard software systems are mostly based upon experiences with a large number of companies, the capitalized knowledge that is reflected in these systems does not have to be built up in-house. Furthermore, the software vendor generally has more experience with the technologies required, as well as with software development and programming.
2. The *maintenance costs* are far less than for a bespoke system as these mostly come down to a subscription fee for bug-fixes and access to the helpdesk. Finally, new versions or upgrades of unmodified standard software packages are mostly easier to implement.

3. The *time* for purchasing or leasing a standard software package is negligible compared with developing a bespoke system. Together with the lower initial investment this generally leads to a shorter payback period.
4. For most standard software packages there exist *user groups*. These user groups enable users to share experiences and to take a collective position towards the software vendor.

These advantages are often so impressive that the disadvantages, especially the assumptions about business processes and users underlying the system, seldom counterbalance these advantages. The development of a bespoke system is therefore even hardly ever considered anymore. At an early stage, the discussion is then limited to choosing among various available standard software packages.

Purchasing Functionality in Standard Software Packages

ERP Software. In the Netherlands, consultancy firms like Berenschot, Logiplan, Ernst & Young, and Coopers & Lybrand periodically — every two years — survey the ERP market consisting of some 60 commercially available ERP systems (see, e.g., Berenschot and Logiplan, 1994, Lierop, *et al.*, 1996, pp. 14-18). Among these packages are, for instance, BPCS (from SSA), MFG/PRO (from Quad), Oracle Manufacturing (from Oracle), PRISM (from Marcam), R/3 (from SAP) and Triton (from B*aa*N). These surveys typically make use of extensive questionnaires or checklists on functionality. These have been drawn up by the consultancy firms, often over a longer period of time. Part of these questionnaires addresses purchasing functionality. The answers of the software vendors of 60 ERP packages on these questions are summarized in Figure 3-1 (based on the Berenschot and Logiplan survey of 1994).

From Figure 3-1 we can conclude that all of 60 studied ERP systems contain an integrated purchasing procedure. Most of the requirements stated in the survey could be satisfied by the majority of ERP systems. Less obvious requirements, i.e., met by less than 70% of the ERP packages, were related to the possibility of recording delivery schedules per order line, expediting, the registration of cumulative discounts, EDI, vendor rating, and buyer rating. Of the 60 ERP systems, only four met less than 50% of the requirements. These results therefore indicate that the majority of ERP packages apparently cover purchasing requirements quite satisfactorily.

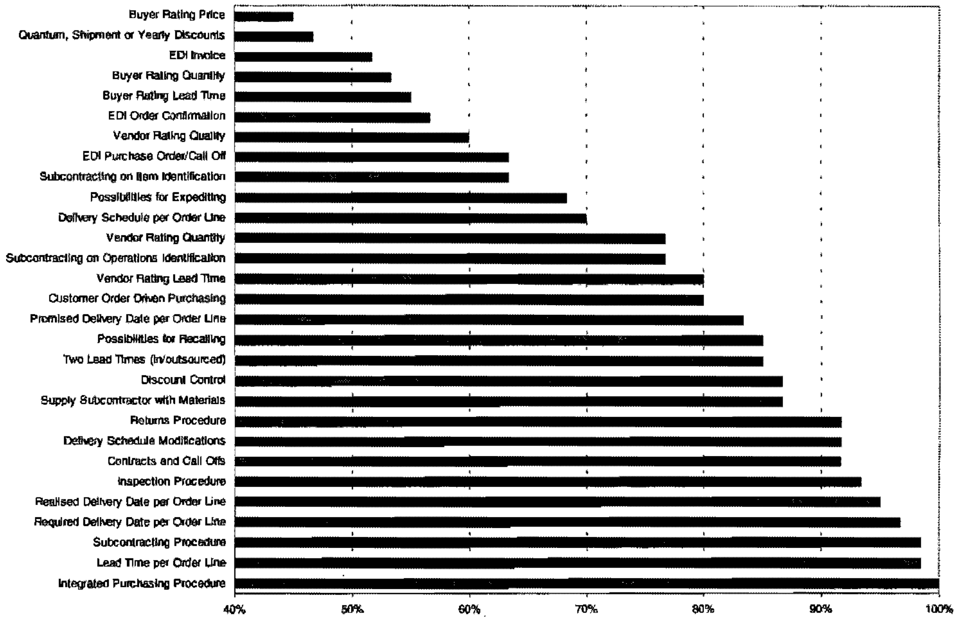


FIGURE 3-1. Percentage of standard ERP packages satisfying stated requirements, based on the Berenschot and Logiplan survey of 1994 (n=60).

There are sixteen ERP packages in the Dutch market that satisfy over 90% of the stated purchasing requirements in the Berenschot/Logiplan survey of 1994. These packages are listed in Table 3-1 on the following page.

There are, however, several remarks that can be made regarding this approach. First, it is obvious that the scope of the questions in the questionnaire considerably influences the apparent empirical coverage of purchasing requirements. The survey, for instance, does not address requirements such as quotation analysis, supplier audits, market research, project management, etc. Furthermore, the survey results are of course commercially biased, as the answers to the questions are provided by the software vendors themselves.

TABLE 3-1. 'Best' Purchasing Software[1]

ERP Package	
CHESS	PROMIX
FOURTH SHIFT	RATIO
IMPCON 2000	SAP R/2
MANMAN/X	SAP R/3
MAPICS XA	STRATEGE
MFG-PRO	TRITON/BAAN
PIUSS-O	TXBASE
PRISM	VISION

A CIPS Study on Purchasing Software. For a similar survey on 87 software products specifically aimed at an assessment of functionality for purchasing and associated activities like warehousing and inventory management, we refer to a CIPS[2] publication (Fogg, 1994). This study concluded that only 32% of the software products in the survey met all the core functionality requirements as set by the CIPS Information Systems Committee (p. 16). It continues by saying that "the area where functionality scores were highest was warehousing; the area where scores were lowest was again the enquiry/quotation area" (p. 33). This area addressed functionality such as the availability of a format enquiry document for suppliers, item level evaluation criteria and quotations, lowest cost option calculation, and the possibility to calculate the percentage of successful quotations per supplier. The CIPS study also revealed that "the specific areas of purchasing which could benefit from further development are enquiry, quotation and assessment, expediting, meeting the needs of EU legislation, inventory control, and specific time saving transactions which avoid re-keying" (p. 32).

To further illustrate the functionality that can be expected from standard software packages, the following two Industry Snapshots describe the purchasing functionality of two of the most prominent software packages in industry, viz., SAP's R/3 and B*aa*N's Triton (see, e.g., Edmondson, 1996, p. 35). These were also the packages that repeatedly occurred on the short lists of the companies that cooperated in this research.

[1] 'Best' is hereby defined as the extent to which the standard ERP software packages satisfy the stated purchasing requirements in the Berenschot/Logiplan survey of 1994.

[2] CIPS stands for the Chartered Institute of Purchasing and Supply.

INDUSTRY SNAPSHOT 3-1. SAP's R/3[3]

R/3 is the ERP package developed and marketed by SAP AG, one of the world's leading vendors of integrated business applications with a revenue of c. 1,100 million DM and over 3,500 employees in 1993. The German software vendor SAP was founded in 1972 and specialized in the development and marketing of standard commercial application software covering the entire spectrum of business functions. Nowadays, SAP is active around the world. Beyond its traditional markets Germany, Austria and Switzerland, SAP is also prominently present in other European countries and the United States.

R/3 consists of software modules organized in three major application sets: financial management and accounting, manufacturing and logistics (containing applications for production planning (PP), sales and distribution (SD), materials management (MM), quality assurance (QA) and plant maintenance (PM)), and human resource management. R/3's purchasing functionality is mainly contained in the MM module, more specific the purchasing application MM — PUR, the inventory management application MM — IM and the purchasing information system application MM — PURCHIS. MM — DB (Basic Data) contains the basic data for the MM module.

MM — BD. MM's basic data application manages data on vendors, materials (incl. bills of materials) and purchasing info (i.e., the link between the vendor and the material or service). It also allows for defining a class hierarchy of materials and vendors. Vendor data (split up in purchasing data and accounting data) includes addresses, agreements, conditions of delivery and terms of payment dependent on the purchasing organization, the vendor, the material or the contract (including the definition of surcharges and discounts). Material data (split up by user departments) involves data on bills of material, descriptions, material type, units of measure and technical information. Purchasing info records (also split up according to user departments) represent the relationship between vendors and materials or services and includes data on prices and price history, texts for purchase order creation, ordering statistics and vendor performance.

MM — PUR. This application is based upon SAP's 'Procurement Cycle'. This cycle starts of with the identification of a requirement through a purchase requisition either entered manually or generated automatically by the MRP application. R/3 can automatically determine the source of supply if a fixed or

[3] The information contained in this section is based upon the following readings: SAP Company Profile brochure (1990), InformationWeek (December 21, 1992), DataMation (March 15, 1993, pp. 26-30), UnixWorld (March, 1993), R/3 System brochure (1992 and 1993), R/3 System — Logistics brochure (1994), MM and PP — Product Overview leaflets (1994), MM and PP — Functions in Detail booklets (1994), MM — Einkauf manual (1993), MM — Einkauf training sheets (1993), MM — Vendor Evaluation Guide (1993), MM — Einkaufsinformationssystem manual (1993).

preferred vendor, agreement or purchasing info record is defined. It can allocate requisitions to several sources alternately based upon quota arrangements for a specific period of time, source and material. A requisition must be approved by an authorized person, based upon conditions such as requisition value or material group, before it can be converted into a purchase order (PO). If it is not possible to allocate the requisition to a source, it can be selected to issue a request for quotation (RFQ). An RFQ can also be entered manually. The data from incoming quotations can be entered into the system so that buyers can carry out a comparative analysis of quoted prices. The data of the most favorable quotation can automatically be stored in the purchasing info record, while rejection letters can be generated for the others. POs can now be generated by referencing requisitions, already existing POs, RFQs or an existing contract. MM — PUR allows for creation of quantity, value and consignment contracts with subsequent release orders and the creation of scheduling agreements with periodically updated delivery schedules. Order monitoring involves the possibility to generate reports on the status of POs. The vendor evaluation facility permits the tracking and review of vendor performance based upon a scoring system enabling the automatic or manual rating of price, quality, delivery and service on a scale of 1 to 100 points. Users are allowed to define more criteria as well as detailing these criteria in so called subcriteria.

MM — IM. The procurement cycle is continued in the IM application with the receipt of goods and the subsequent updating of receipt data by referencing POs. This receipt data is used in monitoring POs, triggering reminder procedures and updating vendor performance records. The vendor invoice is then verified based upon the quantity ordered and delivered.

MM — PURCHIS. PURCHIS is a tool for collecting, consolidating, analyzing and graphically presenting purchasing data. These analyses involve standard predefined analyses (like ABC analyses and rankings) or customized analysis based upon the objects (e.g., vendors, purchasing groups, materials), the time period, and the measures (such as invoice value, number of ordered items, number of deliveries, number of purchase orders, etc.) about which the user wants to be informed. PURCHIS also incorporates the use of selection criteria, to limit the scope of the analysis, and a drill-down function to vary the depth (or detail) of the information displayed. Another tool incorporated in PURCHIS is the possibility to enter planned values for each of the measures, enabling the comparison of planned and actual data. Planning values can be entered manually or supported by forecast models (e.g., trend or seasonal) that are available to the user.

INDUSTRY SNAPSHOT 3-2. *Baa*N's Triton[5]

Triton is the ERP package from *Baa*N, a rapidly growing and pioneering Dutch software manufacturer established in 1980. *Baa*N — with its c. 900 employees (1994) and a turnover of $77.9 million in the first quarter of 1996[6] — began its revolutionary advance in 1982 when it made the right choice for UNIX as the operating system for Triton. The basis for the Triton package was designed by *Baa*N's top system designer J. Hasselman during a sabbatical year at the Eindhoven University of Technology. When UNIX became the new industry standard in the early nineties and the influential Gartner Group posted that *Baa*N would be one of the five survivors in the explosively growing ERP market, *Baa*N became one of the major world-wide players in this market.

The core of the Triton package consists of six applications, viz., Manufacturing, Distribution, Transportation, Finance, Project, and Service. Purchasing functionality in Triton is somewhat scattered over these Triton applications mainly due to the type of product or service being purchased, or the environment (such as a manufacturing, project or maintenance environment). In the following paragraphs the focus, however, is on the purchasing functionality contained in the Distribution application.

Distribution — Common. The Common part of Triton allows the user to maintain master data on, e.g., employees (like buyers), suppliers (including supplier groupings, organizational structures, several addresses (for communication and factoring), texts, assigned buyer, contact person, default currency, quality inspection data, financial data, etc.) and items (containing general item data like item codes, type, texts and descriptions, and data on, a.o., preferred and alternative suppliers, order quantities and policy, delivery time, supplier item codes, quality inspection defaults, prices, units of measure, etc.).

Distribution — Purchase Control. The Purchasing Control module is based on a purchasing procedure that is initiated by a purchasing advice. The purchase advice can originate from an MRP run, a sales order, or may be initiated by inventory control. Based upon the purchase advice and by making use of data already recorded in the item master data, purchase contracts, price agreements, purchase inquiries, or earlier purchase orders, the user can define various types of purchase orders. Triton allows each purchase order type to be handled in a different

[5] The information contained in this section is based upon the following readings: Management Team (Vol. 16, No. 17, October 17, 1994, pp. 47-50), Eindhovens Dagblad (August 10, 1995, p. 7), NRC Handelsblad (April 23, 1996, p. 22), *Baa*N Infoware (Vol. 7, No. 3, September 1994), Triton Tools, Manufacturing, Distribution, Finance, Service, Project and Transportation booklets (1994), Triton Tools, Manufacturing, Distribution, Finance, Service, Project and Transportation — Functions & Features booklets (1994), presentations of the Triton overview course (1994).

[6] This means that *Baa*N doubled its turnover since the first quarter of 1995.

way. This implies the specification of the documents to be printed and the appropriate order procedure to be followed. The EDI module contains messages for purchase orders, order acknowledgments, dispatch advice and invoices.

Purchase orders can be monitored on purchase order line level. If the agreed delivery time is exceeded, reminders can be generated. When the goods are received, they are booked against the purchase order, and goods received notes, storage lists, claim notes (in case of quantity differences) and return notes (in case of rejected items) can be generated. The supplier's invoice is subsequently checked against the purchase order (at that time considered as the proforma purchase invoice) in Triton Finance.

The Triton Purchase Control module also contains functionality to report and graphically present information on order history (by period and by item and supplier) and purchase statistics (by country, area, line of business, order type, supplier group, supplier, buyer, item group, etc.). Furthermore, the module contains functionality to monitor supplier reliability (i.e., based on the history on agreed/actual delivery dates and ordered/approved quantities).

Distribution — Quotation Inquiries. The Quotation Inquiries module allows the user to enter requests for quotations, to generate reminders, and to subsequently enter the received quotation data such as price, discount, delivery date, tax, date returned, expiry date, etc. The offers can be compared, and the most favorable quotation can be converted into a purchase order as was already indicated in the foregoing. The module also allows for recording the inquiry history by supplier and item.

Distribution — Contracts and Agreements. The Purchase Contracts module gives the user the possibility to define blanket orders for specific suppliers and items (or item groups). The contracts can be accompanied by delivery schedules. A contract can be time- (by making use of an expiry date) and/or quantity-dependent. Contract data can be used in generating purchase orders. Contracts can be evaluated during the contract period (and even extrapolated to the end date) and at the end of the validity period based upon goods receipts.

Triton Distribution also allows the recording of price and discount agreements on various levels (like supplier group, supplier or by supplier/item), possibly graded by quantity or amount and incorporating effective and expiry dates.

Summary of Standard Software Functionality

From the foregoing discussions we can conclude that standard software packages typically support activities such as (De Heij and Van Stekelenborg, 1994, p. 157-170):[7]

1. *Requisitioning*: requisitions — specifying what items to buy and how many — can originate in the planning module of the package or come from a planning department. Production and Sales can sometimes also generate demand specifically routed to purchasing. Furthermore, people within the organization can directly make requests for specific items.
2. *Recording of Conditions*: Most packages allow the registration of conditions that apply to a specific supplier and item (i.e., conditions like price, discounts, lead times, payment and quantities).
3. *Ordering*: the requisitions can normally be translated or combined into purchase orders. In order lines the user can make use of the conditions that are mostly recorded in the system. Some of the ERP packages support the definition of delivery schedules and subsequently the calling off of items within a contract. This is of particular interest for organizations working in a Just-in-Time (JIT) mode. However, the most usual form of ordering is the unique order.
4. *Invoice Checking*: in most cases the matching of orders, receipts and invoices is supported by the software. This matching requires relations between invoices, order lines and receipts but one should be aware of differences when confronted with partial deliveries or working with delivery schedules.

In his dissertation (1996), De Heij concludes that the discriminatory characteristics of ERP packages slowly but certainly shift as a result of requirements put upon these packages by industry. Long term contracts and invoice matching are such examples that were only recently introduced into some of them. Most important discriminatory characteristics that De Heij

[7] Sometimes it is also possible to record requests for quotations. For instance, sometimes it is possible to define a request for quotation as a special kind of purchase order. However, this must be interpreted as a form of improper use of the functionality and it is therefore not included under the heading of typical support to be expected from a standard software package.

identifies are (a) the possibility to model a complex supplier organization, (b) the ability to support the outsourcing of activities (such as transport) and the buying of services, (c) the possibility to record data on higher levels of aggregation (such as item classes), (d) packaging and purchasing BOMs, (e) specific conditions, (f) requesting and recording supplier quotations, (g) (changing) delivery schedules, (h) returns, (i) the buying of specific batches or charges in the process industry, (j) order specific purchasing, (k) the settling of invoices when no receipts have yet been recorded, (l) purchasing history, (m) alternative items, suppliers or combination thereof, (n) multi-site support, and (o) the support of multiple currencies.

Summarized, ERP packages mainly address the purchasing of goods for stock. These goods principally are (relatively) simple, standard and encoded items that are needed for the primary process (i.e., mostly the production or assembly operations) of the buying organization. The procurement of complex products that are attended with ample specifications is less well supported by the existing software. The required functionality to purchase order specific items — requiring relations with purchasing requisitions in other modules (Production, Planning or Sales) — is not always available or only limited. For the outsourcing of production activities only limited support is available concerning the registration of items to be produced externally, materials to be supplied (from stock, internally produced or purchased), and the issue of materials to the supplier. Outsourcing is mostly considered a stepchild and is not very well (or even not at all) supported.

REFERENCE MODELS FOR PURCHASING

When selecting a standard software package, many organizations end up in discussions on the technical requirements of the information system. The functional requirements springing from the actual situation only play second fiddle in these discussions focusing on the technical details of the equipment (Wortmann, 1984, pp. 75-86). Although these discussions are of course relevant, the trend of most software providers moving towards an open systems or UNIX environment will lessen the relative importance of these discussions (Fogg, 1994). Furthermore, the currently existing assessment methods make use of extensive questionnaires or checklists on functionality as we have seen. The disadvantages of this approach are (De Heij and Van Stekelenborg, 1994, pp. 157-170; De Heij, 1994, pp. 211-216): (1) the scope, i.e., the natural tendency to incorporate as many questions as possible in order not to overlook something; (2) the high level of detailing although it is impossible to predict future working methods in such detail; (3) the unclearness about the relative importance of the questions; (4) the quality of the questions; and (5) the quality of the answers.

To provide an answer to some of the drawbacks of currently existing software selection methods, the use of reference models is proposed. As much functionality of standard software packages for logistics control is purely related to registration, most of the functional power of a package is defined by its registrative possibilities revealed in the data model (De Heij, 1994, p. 213). Therefore it is argued by De Heij that an assessment of the data model — which is considered to be the core of many information systems — is a welcome addition to the 'traditional' approach to software selection. By matching the data model of the software package and the data model proceeding from the situation for which a package has to be selected, it is possible to judge the suitability of the software for that particular situation. To make such a comparison possible, it is necessary to describe the data models in the same 'language'. This language is referred to as the *reference data model* (RDM). So, to compare various data models to each other (i.e., the data models of the various standard software packages and the data model of the situation to be supported by the system) they should be projected on the RDM.

During the last three decades, a number of reference models has already been developed, although not all of them specifically for the purpose of software selection. In this section some of these models are discussed concerning the purchasing functionality contained in them. These models are the AEG-Telefunken model (1971), Scheer's reference models (1989), Porter's reference model (1991), and the recent RDM of De Heij (1996).

AEG-Telefunken's Model

The AEG-Telefunken model — named after the organization in which it was developed — is composed of (Hetzel and Köster, 1971, pp. 13-18) a generic, hierarchically decomposed *business model* of an industrial company, consisting of domains, main functions, and functions; and a so called *integration model*, consisting of so called part models (or applications as Greveling (1990, p. 101) calls them) and common data sets or files.

Business Model. One of the domains that is identified in the business model is that of 'Materials Management' (see Figure 3-2). Although purchasing is mostly considered to form a part of materials management, the

AEG-Telefunken model does not explicitly identify a purchasing function. The 'Materials Management' domain consists of eleven, predominantly logistic oriented main functions such as gross and net requirements determination, material issues and administration (including requisitioning), inventory control, stock-taking, and storage. More directly to purchasing related main functions that are mentioned are (pp. 26-27, 66-73):

1. *Supplier Selection,* implying the comparison of supplier offers and the subsequent choice of the 'best' offer, taking into account criteria such as quality, price, delivery time, terms of payment and delivery and central contracts. The main function is subdivided into the functions of (a) Obtaining and Comparing of Offers; (b) Purchase Decision (implying the checking of order proposals, choice of the supplier and the recording of conditions); (c) Supplier Data Management; and (d) Supplier Cataloging.
2. *Ordering,* described as the processing of material requisitions or order proposals into purchase orders for the supplier and goods receipt notices. It also contains the expediting of the delivery and the handling of changes.
3. *Order Monitoring,* implying the monitoring of the purchase order (by checking up upon open orders and order confirmations, and the recording of partial deliveries based upon receipt notices), and the processing of reminders, changes, and cancellations, etc.
4. *Goods Receiving,* covering the acceptance of the goods against the issue of an acknowledgment of receipt, and the checking of the received quantity and apparent state of the received goods.
5. *Quality Inspection,* i.e., the checking of the goods on the required quality.

As can be concluded from the main functions mentioned above, the 'Materials Management' domain mainly describes the purchasing of materials, components, goods, etc. for use in the end product. Another relevant main function, addressing the purchasing of capital goods, is 'Investment Planning', containing functions such as 'providing capital goods', which incorporates the obtaining of supplier offers, ordering and order monitoring. This main function is part of the 'Business Planning' domain.

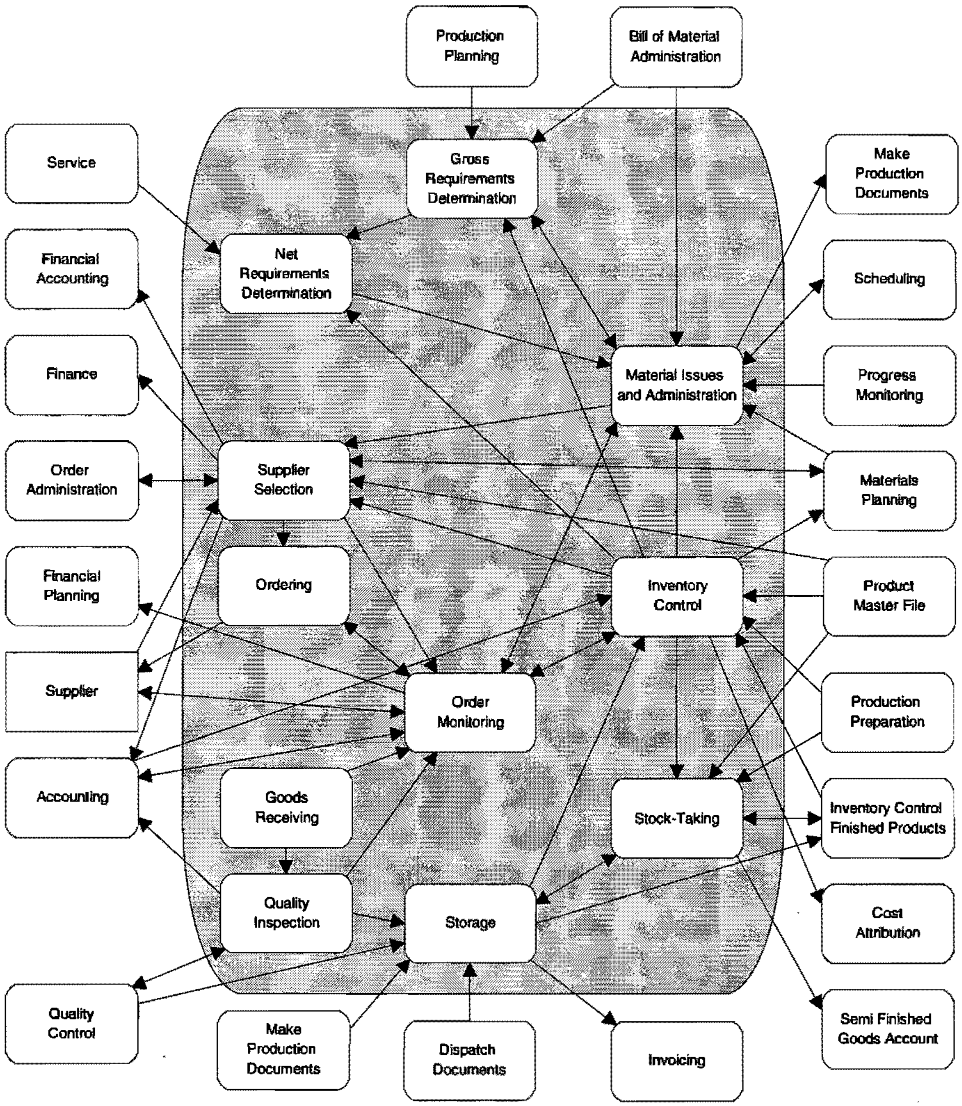


FIGURE 3-2. The 'Materials Management' domain in the AEG-Telefunken business model. *Source*: Hetzel and Köster, 1971, p. 26.

Integration Model. The so called integration model consists of 24 part models that coherently describe the functions identified in the business model. The part models thereby also indicate which functions can be supported by automated information systems and which have to carried out manually, and what common data sets are involved. The part models in the integration model that are relevant from a purchasing perspective are:

1. *Partner File Administration.* The partner file also includes the recording of supplier data and the cataloging of suppliers. The partner file is filled through supplier offers, and is used to produce supplier catalogs.
2. *Ordering.* The ordering model contains functionality for recording purchase orders, order confirmations and partial deliveries, for purchase order writing, and for reporting on open purchase orders, missing order confirmations, past due situations and lacking deliveries. It makes use of the partner and order files.
3. *Goods Receiving and Warehousing.* Relevant IT functionality that is contained in this part model supports the recording of stock mutations in item and the updating of order files.
4. *Creditors.* This part model includes functionality for invoice checking, keeping the purchase accounts (with open entries), and for producing cashless money transfers. The common data sets that are involved are the order, item, partner and open entries files.
5. *Investments, Production Equipment and Capital Goods.* In this part model, surprisingly, there is no explicit IT functionality anticipated supporting the obtaining of supplier offers, ordering and order monitoring (although there is a link with the order file).

Review. From the above we can conclude that the AEG integration model (i.e., the model that addresses IT issues) primarily deals with issues related to the operational purchasing of end product related goods. Supplier offers are only discussed as the means to fill part of the system. Furthermore, the AEG models do not really excel in orderliness and they are somewhat outdated considering their year of origin (1971).

Porter's Reference Model

In the United States, Robert W. Porter — a consultant for Electronic Data Systems Corp. — can be considered one of the pioneers in the development of computerized purchasing systems for industry. Based on Porter's earlier writings, in 1991 Purchasing Magazine published a book entitled "Purchasing Systems for the Nineties". As Porter notes in this publication, the strength of a first rate purchasing system depends to a great extent on the data bases on which it is built. Porter therefore also presents a primary data structure of a so called Class A purchasing System (Porter, 1991, pp. 90) (see Figure 3-3). Porter thereby differentiates between relatively static data, primarily used for reference purposes (indicated as shadowed boxes in Figure 3-3), and more dynamic and transitory data. This last type of data that should be accommodated by a purchasing system is collected and stored as part of performing the business function of purchasing. Major business functions that Porter distinguishes in his purchasing business model are (1) requisitioning, (2) quotation management, (3) contracts, blankets, and releases, (4) purchase ordering, (5) order follow-up, (6) receipt entry, (7) invoice entry, matching and payment processing.

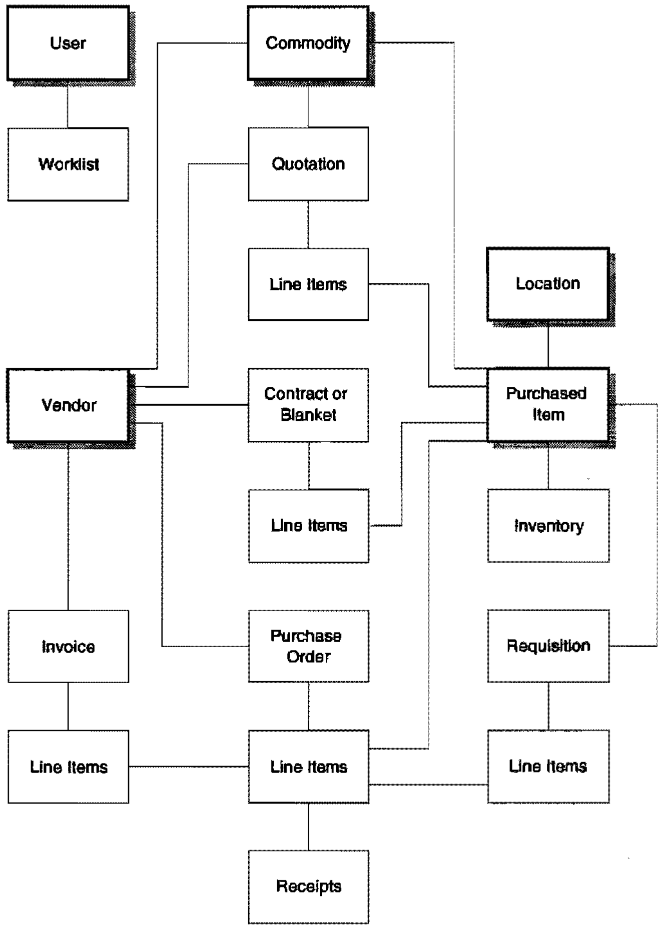


FIGURE 3-3. Porter's primary data structure. *Source*: Porter, 1991, p. 90.

Review. Porter's model can be considered an improvement to the AEG model in several ways. First, it builds upon the starting point that the data bases of the system constitute the core of the system. It therefore explicitly discusses the data model of a purchasing system. His model does not, however, define the exact relationships between the required data sets. Nevertheless, the model explicitly deals with issues such as contracts and quotations in addition to requisitions, orders, receipts, and invoices.

Scheer's Reference Model

A detailed discussion of a typical commercially widely available purchasing system (based upon SAP's R/2 system of those days) can be found in Scheer (1989, pp. 328-358). He thereby distinguishes between (p. 354):

1. *Primary Data Management* (i.e., setting up, amending, deleting, evaluating) of data on materials, suppliers, and buyers;
2. *Offer Processing* (as Scheer calls this), involving the procuring and evaluating of suppliers' quotations and conditions.

As the primary data structures are often filled on the basis of suppliers' quotations, these two topics are handled in the same context (see Figure 3-4).

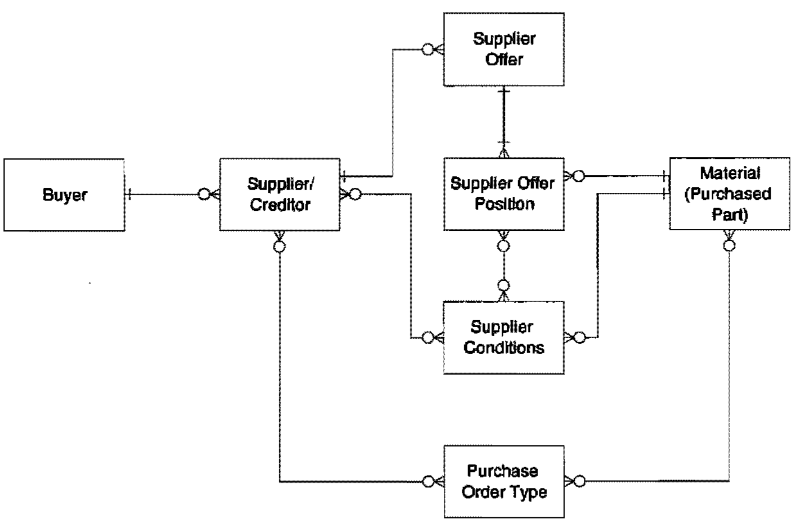


FIGURE 3-4. Entity chart for primary data management and offer processing in purchasing. *Source*: adapted from Scheer, 1989, p. 331.

Scheer continues with structuring purchase data corresponding to the following functions of purchasing:

3. *Ordering* (consisting of demand determination, supplier selection, order quantity determination, and order writing and monitoring) taking into account data on demands/requirements, stocks, cost centers, and purchase orders (see Figure 3-5);
4. *Receipt of Goods* involving the recording of receipts (incl. the updating of stock levels and checking of delivery plans), testing receipts (involving access to data on test plans) and the entering of data on test results (see Figure 3-6); and
5. *Invoice Recording and Checking* introducing the need for data on invoices and creditors (see Figure 3-7).

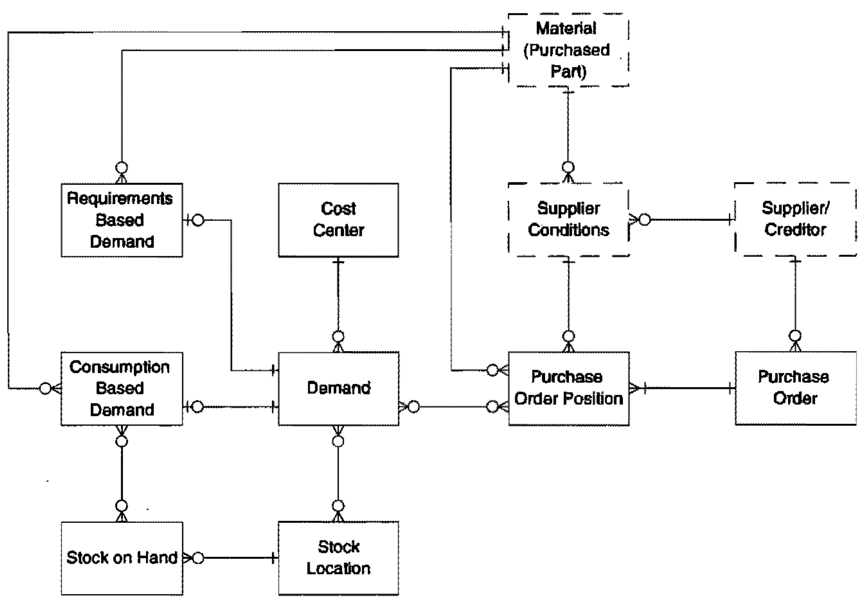


FIGURE 3-5. Entity chart for purchase ordering. *Source*: adapted from Scheer, 1989, p. 338.

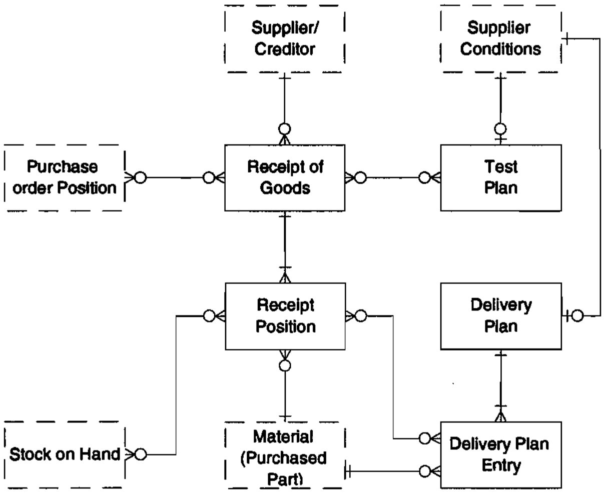


FIGURE 3-6. Entity chart for receipts of goods. *Source*: adapted from Scheer, 1989, p. 346.

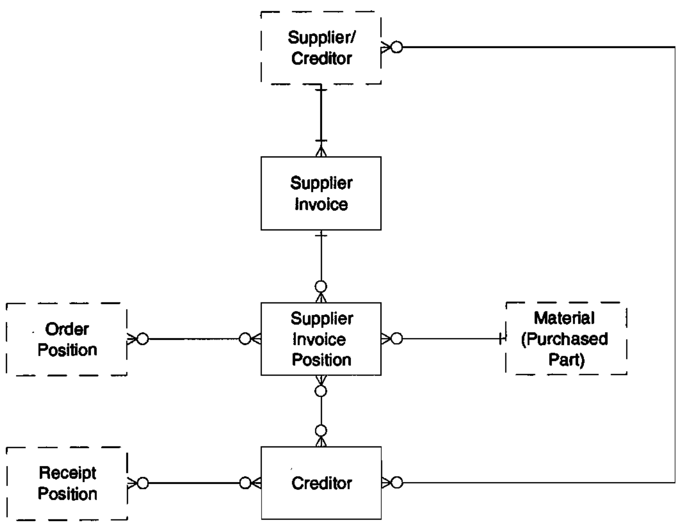


FIGURE 3-7. Entity chart for invoice recording and checking. *Source*: adapted from Scheer, 1989, p. 351.

Review. Scheer's models go one step further than the previous models. Scheer's models are not only of a far more detailed level, in addition to the already identified data sets they also deal with issues such as test plans and delivery plans. Together with the presence of a strong relationship with consumption and requirements based demands this indicates a strong focus on the purchasing of end product related goods that are planned based upon stock levels or MRP. Requisitions, however, are not available.

De Heij's Reference Model

The reference data model of De Heij (1996) was developed specifically with the purpose of improving the software selection process of ERP packages. Like Porter, De Heij also states that the data model constitutes the core of the software under evaluation. De Heij's model therefore only addresses the data structure underlying typical purchasing modules of ERP packages.

As De Heij's model of purchasing is quite sizable, it is decomposed into thirteen part models. It would, however, go too far to go into all of De Heij's part models here. We therefore suffice with summarizing his part models, viz.:

1. *Supplier Organization,* comprising basic supplier data and organizational structures, the factual creditor, etc.;
2. *Purchased Item Typology,* enabling the registration of various types of (purchased) items;
3. *Purchase Bill of Material and Packaging,* for recording packaging materials and other materials to be delivered by the supplier;
4. *Purchase Conditions,* comprising standard conditions, quotations, specific conditions and additional costs;
5. *Purchase Ordering,* the actual ordering by one-off purchase orders, or contract or delivery schedule call-offs;
6. *Receipts,* including the settling of returns;
7. *Requirements and Destination,* involving requisitioning;
8. *Invoicing,* addressing the financial settlement of purchase orders;
9. *History,* encompassing different methods for recording purchasing transactions;
10. *Alternative Items and Suppliers,* involving several methods for determining alternative items or suppliers or combinations thereof;
11. *Delivery Addresses,* for recording special, divergent delivery addresses;

12. *Multi Site Structures,* supporting a multi-site purchasing operation; and
13. *Controlling Data,* addressing some of the remaining issues such as the registration of purchasing personnel, text editing, change control, multiple currencies, etc.

Review. De Heij's model is probably the most comprehensive and detailed one of the models that are discussed. In addition to the issues already discussed, De Heij's model deals with complex supplier organizations, a separate purchasing BOM, and multi site purchasing.

Summary of Existing Reference Models

Although the models discussed before differ in their level of detail, the business models all identify purchasing activities like the registration of primary data, ordering, order monitoring, goods receiving, inspecting and issuing, and the settling of financial accounts (invoice checking and payment authorization). Differences occur when looking at the origin of the demand. Some models focus on requirements stemming from MRP or stock replenishments (AEG and Scheer), others focus on individual requisitions (Porter). De Heij seems to be most comprehensive, dealing with both possibilities. Less typical is the presence of quotations, complex supplier structures, item classes, a separate purchasing BOM, and multi site purchasing. Other purchasing issues are not dealt with at all.[8]

Another conclusion that can be drawn from the review is that the reference models have primarily been developed for use in production oriented environments. This reveals itself in the focus on suppliers of end product related materials, components, goods, etc. (and at the same time the absence of specific files for contractors and services), a close link with the production planning functions in the business models, a lacking capacity orientation, etc. Furthermore, based upon a look at the origins of demand that are identified, the reference models do not deal explicitly with customer order specific purchasing.

[8] In particular not with the question of how all these data are collected and recorded as part of the purchasing process. The models all assume the availability of these data.

SUMMARY

This chapter primarily discussed the functionality contained in standard software packages, and more in particular, ERP packages. Furthermore, some existing reference models, mostly representative of the typical contents of ERP systems, were discussed. In brief, it showed that today's purchasing software is very much biased towards the support of operational and routine purchasing activities for end product related, well-known items from known suppliers (i.e., straight rebuys).

—4

New Directions for Purchasing Information Systems

In a Philips Corporate Purchasing Publication, the former purchasing manager of one of Philips Medical Systems' Program Management Groups, Ton Schipper, states that "the modern view of purchasing is a far cry from the old ideas which defined purchasing. With purchasing extending into the fields of product development and marketing, it has become a more comprehensive job with a greater range of difficulties. ... . In order to effectively supervise the total purchasing process, it is essential to have a professional measurement and reporting system, which provides insight into the whole process (both initial purchasing and procurement)." In cooperation with the Information Systems department and organizational staff, he invested a great amount of time and effort into considering how best to provide a clear picture of the effectiveness of the purchasing process resulting in a performance survey report covering price developments, the number of new part numbers, the number of engineering changes, the number of quality plans at suppliers, expenditure levels, the number of suppliers, vendor ratings, the quality of primary purchase data, the throughput time of invoices, and personnel (Slater, 1994, pp. 9-11).

CHAPTER CONTENTS

After having analyzed the current state of affairs in detail, it is time to prepare for the design oriented part of this dissertation. As in any design process, the needs of the future users play a central role in determining the new design. Based upon the initial case studies carried out at four different companies, this chapter tries to capture the new needs of purchasing. As the example above already illustrates, purchasing has changed and this change should be reflected in the systems supportive to it. This chapter thus provides an initial understanding of the direction in which supportive information systems for purchasing should evolve to support the contemporary industrial purchasing function. The results of this chapter can therefore also be interpreted as an initial 'statement of requirements' that can be seen as a starting point for the design oriented part of the research.

IDENTIFICATION OF REQUIREMENTS

Design typically starts of with a problem analysis activity aiming at an initial statement of requirements. These are the requirements the design — in this case of an information system — should satisfy. In this research we thereby focus on the functional requirements that can be put upon the information system. These requirements define the functions of the system, i.e., what data should be processed, stored and provided. Functional requirements therefore address the data that should be accommodated by the system, and the processing that has to take place on these data to provide purchasing professionals with the required information. It was already stated before that this type of requirements is dependent on the purchasing decisions that have to be supported, the typical decision making situations that can be come across, the way in which purchasing decisions are made, and how purchasing is managed. In the next sections the requirements stemming from these aspects are identified in broad outlines.

As the future users (and uses) play a central role in identifying the needs, the first series of case studies that were carried out in 1992/1993 play a central role in this chapter. They also play an important role because of the importance of a requirements specification that is understandable and meaningful for the purchasing professional. In the next sections we introduce the companies in which the case studies were carried out (DAF, Philips Electronics, ASM Lithography, and Akzo Chemicals[1]), the developments that

[1] It should be noted that the information provided in this chapter is based upon the status of these companies and their purchasing operations in the period of c. 1991-1993. Although the next sections are primarily written in present tense, this does not reflect the companies' current status or practices.

take place in their purchasing operation, and the effects thereof for the required support from information technology.

DAF

In 1991, DAF was one of Europe's major truck manufacturers, with an annual production in 1991 of c. 50,000 vehicles which were sold in virtually all European markets and in over 40 countries outside Europe. DAF's product range stretched from 2-ton vans to over 50-ton trucks. DAF employed a work force of around 13,000 employees, most of them working in the three countries where it had production plants: the Netherlands, Belgium, and Great Britain. DAF also had assembly plants in eleven countries outside Europe. In 1991, DAF had net sales of over US$ 2.6 billion.[2]

Although major components such as engines, axles, chassis, and cabs were made in-house, 70% of all parts were purchased. Because of DAF's high level of outsourcing typical for the automotive industry, the primary operations of the truck manufacturer were mainly limited to research and design, marketing and sales, purchasing, and the (customer specific) assembly of trucks. Next to these activities, DAF also operated an extensive international truck service network (ITS). To guarantee reliable service, DAF held stocks of spare parts, not only of the vehicles of the current series, but also of vehicle types that were no longer in production.

In its purchasing operation, DAF adopted a dual sourcing policy. It also attached much importance to global sourcing. The purchased parts were largely manufactured to specifications set by DAF. DAF aimed at long standing relationships with many suppliers of important parts, and generally the principal suppliers had contracts running for one to five years. Because of the competitive and economic pressures DAF was undergoing in 1991, DAF worked closely together with its suppliers, especially to lower parts costs.

Purchasing formed a part of the Purchasing and Logistics sector, which in its turn came under Production. The purchasing organization itself was (functionally) subdivided into Production Goods (PG) (again subdivided in supplier specific goods and DAF specific goods), Non Production Goods (NPG), and Spare Parts and Accessories. The Procurement departments at plant level were responsible for the actual ordering of production goods.

[2] These figures (and any other in this chapter related to the case studies) are valued against the currency rate of those days, i.e., US$ 1 = NLG 1.86.

Two staff departments were available to respectively UK and European plant operations, viz., Supplier Quality Assurance and Purchasing Preparation and Support. Furthermore, Corporate Purchasing addressed issues such as the analysis, planning, support, coordination, and control of purchasing, project purchasing, global supply market research and counter trade, and personnel.

Purchasing Activities and Developments at DAF

Production Goods. In purchasing production goods, a distinction was made between single and continued orders. Single orders resulting from requisitions were directly handled by Procurement. After checking the actual supplier and price information, single orders were combined into purchase orders. In case of a continued order a clear partition could be seen between the commercial, initial purchasing activities carried out by Purchasing, and the logistic, repeat ordering activities carried out by Procurement. For continued orders, Purchasing maintained a close link with Product Development and Manufacturing Engineering (in particular concerning the manufacturability of the designs). Purchasing was responsible for thoroughly assessing suppliers, after which they were registered in the Approved Supplier Register (ASR). After contracting the suppliers, the procurement department placed the call-offs. The Purchasing department was also responsible for market research and optimizing supplier performance and relations.

Two developments significantly affecting purchasing were the PAC project (Purchasing Action Coordination), aiming at realizing significant cost reductions, and the implementation of a customer order driven, lean enterprise. The PAC project resulted in a clear cost focus in DAF's purchasing operation like shadow calculations and cost price analyses. DAF's Project Purchasing department was responsible for the supply base reduction program within the framework of the PAC program. This program aimed at the reduction of the number of suppliers by 50%. The performance of buyers was also evaluated in terms of achieved cost reductions. Standardization and Early Supplier Involvement (ESI) were also expected to yield significant cost price reductions. The strive for a customer order driven, lean enterprise aimed at lower inventory levels, and enabling a higher degree of flexibility. For the purchasing of product related goods this meant that purchasing was increasingly confronted with customer order specific products, resulting in less predictable product specifications and smaller series.

Another development was the introduction of the already mentioned Project Purchasing department. This department was set up to coordinate purchasing activities during new product development projects. Main activities therefore were related to improving the product design, Early Supplier Involvement (ESI), standardization, supply market research, and cost reduction. Project purchasing thereby played an intermediary role between the involved departments (like Marketing, Product Development, Manufacturing Engineering, and Calculation) and the supply market.

Other relevant departments were the Market Research & Countertrade department that came under Corporate Purchasing, and the two staff departments Purchasing Preparation and Support and Supplier Quality Assurance. The Market Research & Countertrade department was responsible for supply market research supportive to global sourcing (i.e., outside Western Europe) and various countertrade practices (like complying with off set or local content obligations, contractual purchase obligations, barters, and swaps of export credits). Purchasing Preparation and Support was responsible for, a.o., investing in and controlling of tooling located at supplier sites. Finally, the Supplier Quality Assurance department (SQA) was responsible for both preventive actions towards suppliers (like quality audits, improvement programs, and quality agreements) and inspections.

Non Production Goods. Non production goods were again subdivided into capital goods (including exploitation and technical maintenance) (NPG I), and services (NPG II).[3] The purchasing of capital goods was characterized by the presence of high technology products, large investments, long product life, and a low degree of repetition. Purchasing therefore maintained close relations with DAF's Advanced Manufacturing Engineering department (AME). Purchasing saw itself as an intermediary between the supplier market and AME, and therefore payed much attention to market research and supplier assessments. Because of the often large investments involved in buying capital goods, these decisions were often taken by a team, and mostly within the framework of a capital budget. Furthermore, cost price and total costs analyses, and safety assessments played an important role in these investment decisions.

Spare Parts and Accessories. In the after sales market of spare parts, seasonal patterns occur. Historical data therefore played an important role in forecasting sales. Furthermore, the purchasing of parts and in particular

[3] Services were not further analyzed in this case study.

accessories could be characterized as 'merchandising', as a very direct relation exists between marketing and sales and purchasing. As cost reductions were therefore also directly visible, the emphasis in parts purchasing was on costs and most negotiations with suppliers mainly concerned sales margins.

Purchasing of spares and accessories was also subdivided into single orders and continued orders. Most of the orders for spares and accessories (i.e., 85% of the purchasing turnover of spares and accessories) are continued orders for which delivery schedules were agreed with suppliers.

Purchasing Information Systems at DAF

At the time of the case study, DAF's Purchasing Planning & Control department was in the midst of a Purchasing Information Study (PIS). This study aimed at answering questions such as what systems were available for purchasing. The results of this study together with the results of several interviews conducted at DAF are summarized below. An overview of the information systems covered in the Purchasing Information Study is depicted in Figure 4-1.

Production Goods. The purchasing of production goods was mainly supported by an outdated mainframe system supportive to ordering. The mainframe system also provided access to item specifications, parts lists, production planning data, some contract data, suppliers, and turnover. Furthermore, extensive use was made of more generic PC based applications like text editors, data base applications, and spreadsheets. Examples of applications that were built using these tools were in the field of management information (e.g., turnover per supplier, price trends and history), cost reduction prognoses, recording of the Approved Supplier Register (ASR), and standard purchasing documents. Supported by the Purchasing Preparation and Support department some experimental EDI links with suppliers existed.

In the Project Purchasing department several applications were used. These provided support for recording new parts and suppliers, tooling, contracts, and project planning data (like milestones, release moments, progress and status reports, costs, and open purchase orders). For the required reporting functionality a PC application was used. Market Research & Countertrade only used a PC based registrative system for maintaining a supplier file and a trading house file. The SQA department used applications for recording quality inspection data and supplier performance data. For determining supplier delivery reliability, SQA had developed a PC based application. SQA also kept a separate supplier file on a PC.

Non Production Goods. In purchasing non production goods, there was hardly any IT support. Next to the ordering system on the mainframe, there were some PC based applications used for comparing quotations and for writing standardized reports.

Spare Parts and Accessories. Spare Parts and Accessories had information systems at its disposal with data on items, prices, purchase orders, purchase requisitions, and suppliers. This system was mainly used for ordering. Furthermore, a cost reduction performance measurement system similar to the one used for production goods was available.

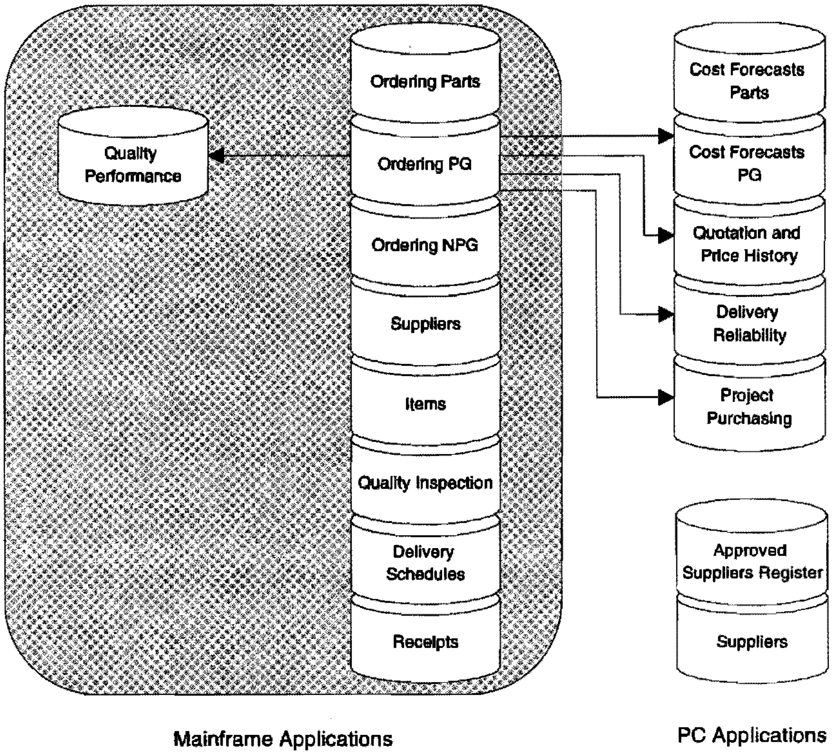


FIGURE 4-1. Purchasing related information systems at DAF. *Source*: adapted from the DAF's Purchasing Information Study, 1992.

From DAF's Purchasing Information Study it was concluded that the support of operational purchasing activities and the recording and maintenance of primary data (mainly on suppliers, items and purchase orders) did not require immediate attention. However, as most of the (mainframe) systems at that time were outdated (they were implemented in the seventies), the developments in the purchasing function were not or hardly reflected in these systems.[4] This had led to the use of many end user developed PC applications, that to some extent answered the needs of DAF's purchasing professionals. However, these systems were not integrated, not supported, not documented and had to contend with many consistency problems.

New Requirements on DAF's Purchasing Information Systems

At DAF the management realized that the use of IT in purchasing, and therefore also the requirements put upon IT depended on the purport and content of the purchasing function. As purchasing was on the move, IT support needed to be flexible enough to follow the trends, or even enable the required changes. Particularly the shift from a logistic towards a more strategic orientation of the purchasing function had to be taken into account. In the future the emphasis will be on the relationship between buyer and supplier. Extensive and long cooperation in several areas (e.g., product development, target costing and productivity improvements) will characterize this relationship. The idea behind this was that the relationship is the basis of the experienced operational performance. Performance was considered merely a symptom; the causes of it are hidden in the relationship with the supplier.

The Purchasing Information Study also attempted to answer the question of what type of support would be required to support the contemporary purchasing function within DAF. The results thereof, together with the results from the interviews, are presented below. Requirements that did not relate to functionality were thereby left out.

Production Goods. Needs that were expressed were related to the field of (a) price trends and history, (b) budget and cost statements, (c) coordination of purchasing activities (related to exploiting DAF's purchasing power towards suppliers), (d) parts standardization, (e) external logistic integration (i.e., EDI), and (f) management information.

[4] Meanwhile DAF has replaced these systems with *Baa*N's Triton.

Project Purchasing, Supplier Quality Assurance, and Market Research & Countertrade all expressed the need for management information and flexible reporting systems. In the area of Market Research & Countertrade, purchasing professionals further expressed needs concerning the accessibility of data on material specifications, cost breakdowns, future logistic requirements, and data on vehicles and their parts that are already allocated to a specific market (because of the presence of possible off set obligations).

Non Production Goods. The needs that were expressed regarding the support for the purchasing of non production goods could be categorized into (a) keeping up with technology developments and trends in the supply market and at competitors, (b) on-line accessibility of historical data, and purchasing knowledge and experience, (c) applying the total cost approach to capital goods buying, (d) supporting the increasing number of lease cases in the non production goods area, and (e) Early Supplier Involvement (ESI) in decision processes concerning capital goods.

Spare Parts and Accessories. The Spare Parts and Accessories department finally expressed needs that related to (a) cost reduction programs and cost reduction prognoses, (b) requesting quotations, (c) flexible reporting facilities and management information, (d) enhanced registration possibilities, (e) communication facilities, and (f) change control (also towards suppliers).

Summary. The requirements from the DAF study can be summarized as a need for (a) enhanced *registration* of and access to data (on budgets, prices, cost breakdowns, material specifications and engineering changes, supply market, technologies), (b) *historical* data (prices and performance) and *forecast* data (requirements), (c) (total cost) *decision models* and functionality for *requesting quotations* in supplier selection decisions, (d) flexible *reporting* functionality, *management information* (i.e., aggregations and cross sections), and *communication* facilities for improving purchasing decision making and enabling coordinated buying, and *integration* with suppliers (EDI and engineering changes).

PHILIPS ELECTRONICS

The well-known Dutch multinational Philips Electronics — founded in the 19th century — is organized into Product Divisions (PD's) and National Organizations (NO's). Well-known PD's in 1991 were Components, Consumer Electronics, Domestic Appliances and Personal Care, Industrial Electronics, Lighting, Medical Systems, and Telecommunication and Data Systems. The 60 NO's were mostly subsidiaries, responsible for local strategy, production and sales, and acted as a geographic representative of Philips towards other parties. Philips operated 295 factories in 47 countries and it had marketing and sales outlets in c. 150 countries around the globe. In 1991, Philips had a turnover of over US$ 30 billion, with a multinational workforce of 250,000 employees.

Worldwide, Philips employed nearly 3,000 buyers and purchasing managers that worked in c. 400 purchasing departments. These departments generally were organized according to activity (initial purchasing and repeat purchasing) and the type of good or service being bought. Types that were recognized within Philips were product related and non product related goods and services. Furthermore, goods and service categories used were (1) raw materials, (2) mechanical components, (3) electronic and electro-mechanical components, (4) value added resale products, (5) MRO supplies, subcontracting, transport and engineering services, and (6) capital goods.

The purchasing departments of local companies were directly responsible for the buying of the goods and services required by that company. Goods and services that were eligible for national or international coordination, were contracted centrally (either on the level of the Product Division or — in case of non product related goods — the National Organization) after which Local Purchasing Departments participated in the contract. Philips Corporate Purchasing covered functions such as management development, automation, and methods and procedures. Furthermore, Corporate Purchasing coordinated the buying of strategic raw materials, and of company wide hard- and software.

Purchasing Activities and Developments at Philips Electronics

Philips Electronics historically always had been a relatively vertically integrated company. In the early days this was required to secure raw materials supply and improve the efficiency. In the last 25 years, as a result of a sweeping reflection on its own core business, Philips had, however, increasingly outsourced its operations.[5] As a result of this 'outward orientation', suppliers had become a very important part of Philips' strategy representing c. 60% of sales turnover (c. US$ 18 billion annually) (Andriesse, 1992, p. 36). Furthermore, the nature of the outsourcing had changed from simple subcontracting of operations for reasons of insufficient capacity and the supply of simple parts, to the supply of complex subassemblies and complete functional (sub) systems. As a result the share of raw materials purchases was decreasing. Furthermore, the share of finished products in the total purchasing product portfolio was increasing (not only as a result of outsourcing complete systems, but also because of Philips' assortment extensions).

Philips had adopted a differentiated strategy towards its purchasing operations. This was a necessity because of the variety of goods and services that were bought by the organization. These strategies were reflected in the performance criteria and processes adopted in the various areas. In the case of raw materials, for which global markets existed, a thorough knowledge of the market was considered a prerequisite. To ensure effective purchasing, Philips therefore had adopted a centrally coordinated purchasing operation. The category of mechanical parts and subassemblies required a total different approach. These products were mainly designed by Philips, and — for the sake of manufacturability — required close interaction with suppliers during product development. These products were mostly sourced from regional or national suppliers. Electromechanical parts were bought in the global market place in which Philips itself was of course also active. These purchased components were mostly standardized (i.e., not designed by Philips), and were subject to rapid technological developments. In this category Philips repeatedly evaluated its 'make-or-buy' policies. For capital goods, the 'total cost of ownership' criterion (TCO) was decisive. The finished product category required a thorough market knowledge as well as insight in cost structures of both products and countries. Finally, MRO supplies and services were bought locally, although Philips aimed for international standardization. For these type of goods, Philips intended to reduce the administrative complexity through decentral ordering, periodic checks and cumulative invoicing.

Throughout its purchasing operation, Philips clearly discriminated between initial or tactical purchasing activities, and repeat, operational purchasing activities. Initial or tactical activities thereby comprised activities

[5] For an interesting historic account on these developments we refer to a book entitled "Philips and its suppliers" (Royen, 1991).

such as make-or-buy decision making, product specification, supply market research, supplier qualification and selection, and contracting. The operational purchasing process covered orientation (i.e., communicating rolling purchase forecasts), ordering (or call offs), order monitoring, receiving and inspection, and invoice settling and payment. The invoices from Dutch plants were thereby collected and settled by Corporate Purchasing. This enabled Corporate Purchasing to gather valuable information on turnover per product and supplier. After adding any foreign turnover data, this enabled them to contract suppliers for specific volumes using the leverage of an organization of Philips' size. Local purchasing departments could then order their requisites from within these centrally coordinated contracts.

Because of the changed importance and nature of the purchasing function, purchasing had the increasingly important responsibility to reduce supply lead times and costs of purchased materials, and at the same time to improve the quality thereof. Philips believed this could be done through the deepening of the relationships with increasingly fewer suppliers, which was one of the four pillars of Philips' strategic quality program entitled 'Let's Make Things Better'. The traditional focus on the operational, executive and routine purchasing activities was therefore shifting towards a focus on the commercial, initial purchasing activities and the implementation and management of relationships with suppliers. In the future, purchasing therefore had to be seen as a 'relationship manager', and the initial and commercial tasks of purchasing would be increasingly separated from the operational and logistic procurement tasks.

Among other things, this shift implied a stronger focus on purchasing activities such as market research (addressing potential suppliers and supply markets as well as emerging new technologies), supplier selection and evaluation (in which ISO 9000 certification of suppliers and the use of the 'total cost of ownership' criterion played an important role). It also led to more comprehensive and long term contracts that formed the basis for performance measurement, assessment and improvement. Suppliers would also be increasingly involved in Philips' product development processes (Early Supplier Involvement — ESI). Furthermore, Philips' increasingly international and decentralized nature implied a continuous focus on international standardization and the cost structures in the numerous countries where goods and services were bought.

Purchasing Information Systems at Philips Electronics

Within Philips, a distinction was made between (central) initial and (local) initial and operational purchasing systems. Furthermore a distinction was made between systems for product related and systems for non product related goods. The most important systems that were available are depicted in Figure 4-2.

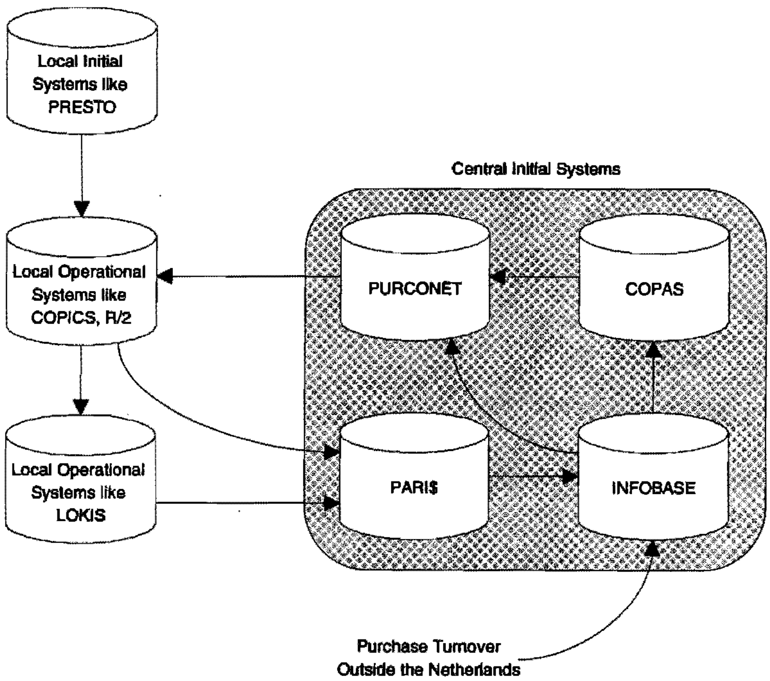


FIGURE 4-2. Purchasing systems at Philips Electronics.

For local operational purchasing activities, the already discussed ERP systems (or predecessors thereof) were common, possibly extended to support vendor rating activities. Some of these systems were even developed specifically by Philips. Because of this, the purchasing functionality normally found was mostly part of a more comprehensive and integral production control system. Examples of systems used by Philips were (mostly) COPICS, R/2, MFG-PRO, TOLAS, and POLIS.[6] However, this does not imply that

[6] Meanwhile some Philips plants have also implemented *Baa*N's Triton.

every Philips plant could make use of this type of (integrated) functionality. If no support was available, or if users did not want to make use of the mostly very user unfriendly integrated systems, buyers and purchasing managers could make use of LOKIS, a stand alone Philips application (although in some cases interfaces with COPICS had been built). The LOKIS application was originally developed to support the operational purchasing of non product related goods (i.e., from ordering through invoice settlement).[7] LOKIS, however, did not address issues such as inventory control, MRP, or requesting quotations.

Local systems supportive to initial purchasing activities were not always known centrally. An example hereof was the PRESTO system at APT (a former joint venture of AT&T and Philips Telecommunications). This system addressed initial purchasing issues and contained data on suppliers, items, contracts and agreements, conditions, and technical and commercial release status of items, suppliers and combinations thereof. Furthermore, many stand alone and PC based applications in the field of supplier evaluation, report writing and total cost evaluation could be come across locally. These were also mostly not known to Corporate Purchasing. Corporate Purchasing had, however, developed several prototypes to support the total cost approach for different product categories.

To support its central initial purchasing activities, Philips Corporate Purchasing made use of several systems, viz., PARI$, INFOBASE, COPAS, and PURCONET. These central systems mainly supported the settlement and payment of invoices (PARI$), aggregation of financials into turnover per supplier, product group, and purchasing group (INFOBASE), registration of contracts on products and prices (COPAS), and distribution of contract and financial data (PURCONET). The data base of PURCONET contained data on c. 100,000 suppliers, 1,400 agreements, and 135,000 products with prices.

New Requirements on Philips' Purchasing Information Systems

During the case study, both current requirements and future directions were distinguished. Current requirements were requirements that directly related to the systems identified before. Future directions were needs that were expressed that related to the developments in purchasing strategies and practices.

[7] Since then, some locations (e.g., Philips Display Components) have also implemented third party software to address this area (e.g., SmartStream Procurement).

Current Requirements. Regarding the systems that were in use, Philips aimed at the integration of systems like LOKIS and the MRP systems that were in use. This should enable Philips to provide more user friendly support to purchasing professionals.

Furthermore, a major drawback of systems like PURCONET was the lacking support for Philips' Supplier Partnership program. This program, for instance, required a drastic cut down in the number of suppliers. However, as only the major suppliers were registered centrally, supply base reduction initiatives remained a local responsibility. A widely dispersed and large organization as Philips further implied many problems in collecting centrally required data, and in their consistency and reliability. Many of the required data therefore still was gathered in informal ways, by making use of Philips' networking organization. Restructuring centrally available data was one of the topics that were addressed at that time.

Because of the existence of many outdated MRP systems at that time, Philips also aimed at short term improvement of these systems to support integral goods flow control principles (i.e., implementation of improved MRP (ERP) systems and EDI).

Future Directions. As a consequence of the increased importance of purchasing within Philips, purchasing would increasingly be working in a 'glass house', i.e., it would attentively be kept an eye on by general management. This implied that high quality management information systems were required. These systems should not only provide aggregate data on key factors and on various levels (viz., Corporate Purchasing, National Organizations, Product Divisions and Local Purchasing Departments); they also should enable managers to query the detailed data for the underlying causes of the observed trends or deviations ('zooming').

Furthermore, because of Philips' shifting purchasing paradigm, there would be an increased need for IT support in the initial purchasing activities like supplier selection and evaluation, and in performance measurement (of delivery reliability and quality) and assessment. The coordinating role of Product Divisions, National Organizations and Corporate Purchasing required data on who buys what, where and at what price, used in purposive analyses (in particular to come to cost reductions in the contracting of suppliers).

Finally, the dispersed nature of a corporation like Philips required an effective and efficient communication network as well as agreed data definitions between Local Purchasing Departments, National Organizations, Product Divisions, and Corporate Purchasing.

Summary. The requirements from the Philips study can be summarized as a need for (a) improved *logistics* (ERP) systems and logistic integration (EDI), (b) tools that can be used in *supplier selection and evaluation*, (c) *performance* measurement (of delivery reliability and quality) and assessment, and (d) *central visibility* of purchasing activities throughout the organization, requiring high quality *management information* systems (providing aggregate data on who buys what, where and at what price, and on various organizational levels), flexible *query tools* that can be used in 'zooming in' on the underlying causes of the observed trends or deviations. Finally, the dispersed nature of Philips requires effective and efficient *communication* facilities.

ASM LITHOGRAPHY

ASM Lithography

ASM Lithography is a company that dedicated its resources to research, development, manufacturing, marketing and servicing of advanced wafer steppers; manufacturing equipment based on photo lithographic technology that was used in the manufacturing of high density integrated circuits ('chips'). With this technology, accuracies of less than 0.25 micron and an overlay of 30 nm. could be achieved. ASM Lithography was founded in 1984 and had net sales in 1991 of almost US$ 77 million.

The total yearly market volume for wafer steppers at that time was c. 500-1,000 steppers. Considering ASM-L's market share of c. 10% implied that yearly production amounted to c. 50-100 steppers. The main markets for this type of equipment were the US and Taiwan. ASM-L's facilities in the Netherlands and USA, and its local representatives in the Far East enabled to sell and service products in the major semiconductor markets. Main competitors of ASM Lithography were Nikon and Canon, and — to a minor extent — GCA and UltraTech. Despite the fierce Japanese competition, ASM-L could assert itself in the market because of the high quality it could offer in terms of accuracy, overlay and resolution.

ASM-L employed over 600 people of which c. 500 worked in the Netherlands; 16 of them were working in ASM-L's purchasing department in Veldhoven that was organized into three purchasing groups, viz., mechanical (i.e., ASM designed metal and plastic components), electronics and optics (e.g., PCB's, standard components, OEM products, lenses, etc.), and MRO supplies (e.g., chemicals, subcontracting, and services). This subdivision could also be found in the development department and assembly factory. The purchase share of the cost price of ASM-L's wafer stepper was approximately 90%. From this it is also clear that purchasing was considered one of the key organizational functions of ASM Lithography.

Purchasing Activities and Developments at ASM-L

Complex and Technically High-Grade Products. The initial specifications of these products were first discussed with Development, after which Purchasing started its market research. Due to the advanced technologies involved, some of the suppliers were already selected in an early phase of product development (c. 10% of the suppliers). These suppliers were expected to contribute significantly to the product development process (Early Supplier Involvement — ESI, or co-design). This phenomenon was increasingly important at ASM-L. Other suppliers were also selected in the early phases of product development, based upon open quotations and mutual comparison thereof (and with ASM-L's own calculations). During product development, ASM-L's Product Development department intensively communicated with the engineering departments of these early involved suppliers. Purchasing could thereby considered an intermediary or facilitator. In other respects, Purchasing aimed at the standardization of components during product development.

One of the most important developments at that time, was the introduction of 'smart ordering'[8] (or 'phased ordering') for long lead time items. Due to the long lead times frequently related to complex products, ASM-L often experienced logistical problems. By providing suppliers of these items with early planning data (although exact specifications were not yet known) and rolling forecasts, ASM-L aimed at a reduction of the lead time when finally ordering, and at improved flexibility (i.e., the ability to respond to changing specifications). Smart or phased ordering thus separated the product specifications from the logistic specifications (i.e., quantities and timing). In this way ASM-L, made use of the specificity of the operations that the supplier had to carry out on the product, and bought these in a step-by-step fashion. This, however, required a better understanding of the composition of the lead time at the supplier.[9]

[8] SMART is also used as an an acronym for Systematic Material Acquisition and Review Technique.

[9] ASM's 'smart ordering' concept is comparable to the MLSC principles discussed earlier.

Simple Products. For simple products there were often several suppliers, in contrast to the situation of complex products. This meant that in initial purchasing there were more alternatives available to purchasing. However, for repeat buys ASM-L preferred working with a relatively fixed set of suppliers that could be educated in a mutual beneficial relationship.

For this type of product, ASM-L also aimed at a separation (or decentralization) of the operational ordering activities (that were going to be part of the logistics function within ASM-L) and the value adding, initial purchasing activities.

MRO Supplies. For MRO supplies, numerous alternatives existed in the local or regional market. Therefore ASM-L had adopted a competitive bidding strategy for the goods and services, which also involved more price based negotiations. The requirements for these products and services was forecasted based upon historical data, although this was not considered a very reliable method. For some of the small parts a minimum stock level with a minimum order quantity was also used.

Purchasing Information Systems at ASM-L

In 1992, ASM-L used Xerox' MRP system XBMS.[10] XBMS accommodated data on, e.g., items, parts lists, inventories, orders and financials. ASM-L also had the possibility to use XBMS for vendor rating and requesting quotations, however, due to the rigidity and poor user interface of XBMS, these systems were developed stand alone. XBMS enabled ASM-L to calculate net material requirements, to generate and print purchase orders and delivery schedules, and to record suppliers, order confirmations, and receipts. The system also allowed the answering of typical questions regarding preferred suppliers, turnover per supplier, latest price, supplier lead times, open purchase orders, required delivery dates, etc.

Up to 1992 the use of XBMS for other purchasing purposes was rather limited (sometimes XBMS was even avoided!). Because of the limited management reporting functionality of XBMS, many users built their own PC based applications used for analysis (for aggregations and cross-sections) and simulation (particularly for scheduling), and downloaded the required raw data from the mainframe.

[10] Meanwhile ASM-L has replaced this system with XBMS' successor CHESS.

New Requirements on ASM-L's Purchasing Information Systems

Most actual requirements on which ASM-L was already acting, were related to (1) priority setting for purchase orders, (2) order expediting, and (3) invoice matching. Although the main focus at ASM-L was on *improved logistics* (involving the implementation of 'smart ordering'), the increasing separation of initial purchasing activities from the logistic procurement tasks of purchasing was expected to affect the required IT support. For example, because of the importance of the product development process as well as the purchasing function, ASM-L saw the development, implementation and maintenance of a *standard component library* as an important point of attention. Further points of attention that were expressed during the interviews were the enabling of *analyses and simulations* (in particular for scheduling), and the improvement of *management reporting* capabilities (like flexible queries, aggregation, cross sections, and selection).

AKZO CHEMICALS

Akzo — at that time it had not yet merged with Nobel to form Akzo-Nobel — was a world wide operating group of c. 350 chemical companies spread over 50 countries. Its main office was located in Arnhem. It was one of the big chemical companies in the world, with c. 65,000 employees and yearly net sales of c. US$ 9.6 billion (in 1991). Akzo's purchase share of net sales was c. 40%. Akzo's activities were grouped into five globally operating product division, viz., Chemicals, Coatings, Fibers, Pharma, and Salt and Basic Chemicals.

The Akzo Chemicals Division produced a wide range of roughly 7,500 special chemicals, all developed for specific customer applications like fabric softeners, paper, cosmetics and plastics. Within the Akzo Divisions, the activities were decentralized in Business Units; more or less autonomous units focused on specific product market combinations. The Business Units had the responsibility for research and development, production, purchasing, marketing and sales.

Almost every plant of Akzo Chemicals in the Netherlands had its own purchasing department. The purchasing of technical materials and services within Akzo Chemicals had been decentralized and took place at local plant respectively regional level. Most of the contracts were, however, negotiated by the Akzo Corporate Purchasing Contracts organization in Arnhem. The Corporate Purchasing department was responsible for project related purchases and company-wide automation. The purchasing of raw materials and packaging materials took place at the divisional level.

The seven people that worked at the Technical Materials and Services purchasing department in Amsterdam bought goods and services to the yearly amount of c. US$ 35 million to keep the local plant in operation. Examples of the c. 25,000 goods and services they bought from the c. 1,000 active suppliers were mechanical, electrical, and construction materials and services, supplies, waste disposal services, and laboratory equipment.

The divisional purchasing department for Raw Materials in Amersfoort was responsible for the yearly buying of c. US$ 250 to US$ 300 million worth of raw materials (such as oil, metals, acids, chlorines, etc.) and packaging materials.

Purchasing Activities and Developments at Akzo Chemicals

Technical Materials and Services. The decentralized, local purchasing groups mostly bought their repetitive standard materials and equipment under central contracts (i.e., price agreements) agreed upon by Akzo Corporate Purchasing Contracts (ACPC). The ordering process could thus be characterized as fairly routine.

Services such as painting, preventive maintenance, insulation, etc. were mostly carried out by locally known 'private suppliers'. With these suppliers a relationship based upon trust was maintained and services were mostly invoiced afterward (mostly after an informal quotation). Only when a particular budgetary limit was exceeded, competitive bidding was used. When doing so, it was important to know the 'tricks of the trade'. For instance, in doing business with building firms it should be noted that these firms had agreed upon charging their costs of offering.

Finally, large engineering projects were mostly handled by a multi disciplinary team in which purchasing was also represented. The most important role the purchaser played in this team, was the estimation of required material budgets and prices during pre-development. To a large extent these estimates determined the investment proposal and the judgment thereof. In estimating these prices and budgets use was made of a so called 'price book' published by the Dutch Association of Cost Engineers (DACE) and the own experience and knowledge. After specifications had been developed, purchasing requests quotations whereby suppliers were chosen based upon competitive bidding (i.e., based upon price/performance). Some of the suppliers of the required project materials thereby might already have been contracted centrally.

Raw Materials. In buying raw materials (like oil, metals, acids, chlorines) which is done centrally, Akzo had to deal with a world market in which only a few suppliers were present. As specifications were not standardized but extremely important to the recipes used in the process industry, Akzo was dependent on these few suppliers. To overcome some of these troubles, Akzo mad use of 'tolling', i.e., raw materials were processed by intermediate contractors so that they complied with Akzo's specifications.

Although the required volume of raw materials was fairly constant, the mix of required materials increasingly was not. Furthermore, more and more safety and environmental regulations added to the already tight specifications, which also affected global transport (im-)possibilities.

The specifications of raw materials were set by Akzo's Research & Development, in consultation with Marketing and the production locations. Purchasing played no part in this process. After specifications had been defined, Purchasing was responsible for finding several suppliers. Akzo was reluctant to enter into single sourcing situations, as they would be too dependent upon the supplier. The required volume was rather spread over several suppliers. After quotations were requested, suppliers were selected mainly based upon price differences (in case quality levels had been assured). Past experiences were thereby possibly taken into account. Contracts addressing specifications, quantities, price (including currency and validity), delivery time, and conditions, were agreed centrally. Summaries of these contracts were distributed over Akzo's locations, after which the local logistic managers were responsible for actually ordering the materials. The central Purchasing department only checked upon the ordered quantities afterward.

As raw materials' specifications were critical to Akzo, sample inspections took place. The results thereof were communicated to the supplier by Purchasing. Purchasing was also responsible for settling any claims that result from this.

Purchasing Information Systems at Akzo Chemicals

Technical Materials and Services. At the Technical Materials and Services Purchasing department in Amsterdam, the PROMIS system on the VAX (PROVAX) supported the administrative processing of purchase requisitions and orders, order monitoring, goods receipts and inspection, financial control of contracted work (e.g., payment authorization, hours accounts, and cost attribution), and some reporting.[11]

Raw Materials. At the divisional Raw Materials Purchasing department there was hardly any support from automated information systems. The only support there was, was a self developed, stand alone, PC based application used for keeping up the price quotations on the global metal market.

New Requirements on Akzo's Purchasing Information Systems

Technical Materials and Services. Automated information systems for use in purchasing were considered relevant in three areas.

First, they could be used in the administrative process where large numbers of data had to be collected, recorded, and processed. Information systems were expected to improve the efficiency considerably. The use of systems in this field might also improve the effectiveness, as they could improve the accessibility, reliability, and clarity of the data. Furthermore, information systems could play a very important role in the integration of the purchasing process with other business processes.

Second, information systems could be deployed in initial purchasing activities. The manager of Akzo Chemicals' Technical Materials and Services Purchasing department in Amsterdam experienced a growing need for support of his supplier assessment activities and the subsequent use of the resulting historical performance data in supplier selection procedures. The available system also needed to be enhanced to support requesting and evaluating supplier offers. Furthermore, IT tools should enable him to track price movements in the supply market. The data on historical performance and price movements could then also be used in better preparing contract negotiations with suppliers and contractors.

Finally, information systems — in particular their possibilities for flexible management reporting — possibly could be deployed in the management of purchasing.

Raw Materials. The divisional Raw Materials Purchasing department had a great need for enhanced market information. Having access to structured knowledge on the specific markets they worked in could greatly

[11] Meanwhile Akzo-Nobel has been in the process of implementing SAP's R/3 system.

improve their effectiveness. At that moment, buyers and management were swamped with journals, brochures, books, flyers, etc. so that the required information was almost inaccessible. Also, information was gathered through visiting trade fairs and conferences, supplier visits, telephone calls with suppliers and internal customers, etc. Furthermore, Raw Materials buyers would be helped if product specifications, budgets, local inventory levels, and production and marketing plans of Business Units were available to them. This also required electronic communication between plants and the divisional headquarters. For the purpose of purchase coordination, aggregation functionality had to be provided.

Summary. The requirements from the Akzo study can be summarized as a need for (a) *enhanced registration* possibilities (e.g., for unformatted *documents* and for recording data gathered during market research activities) thus providing access to market information, (b) data on product specifications, budgets, local inventory levels, and production and marketing plans, (c) support for *supplier selection and contracting* by providing historical performance data and data on price trends, functionality for requesting and evaluating supplier offers, support for supplier assessment activities, (d) flexible management *reporting* functionality and *aggregation* functionality, and (e) facilities for electronic *communication*.

AN INITIAL REQUIREMENTS SPECIFICATION

A first set of functional requirements that can be deduced from the previous examples is discussed below. This discussion is organized according to the factors that are believed to be determinative for the functional requirements (see Chapter 1), i.e., the purchasing decisions and tasks that have to be supported, the typical decision making situations that can be come across, the way in which purchasing decisions are made, and how these purchasing processes are managed.

Purchasing Tasks. In the case studies it was recognized that the use of IT in purchasing, and therefore also the requirements put upon IT should depend on the importance and content of the 'new' purchasing function. One of the most important characteristics of this new purchasing function is a focus on the relationship between the buying and supplying organization. DAF, Philips, and ASM-L were all striving towards closer collaboration with suppliers in various fields. The consequence hereof was an increased attention for the initial purchasing activities.

Therefore, in contrast to most of the currently implemented IT tools, any new applications of IT in purchasing should be more supportive to initial purchasing tasks such as the *selection of suppliers* (e.g., by providing support to performing market research, visiting trade fairs and conferences, visiting, contacting and auditing suppliers, and requesting and evaluating supplier offers). Market and performance data can also be used in better preparing *contract negotiations* with suppliers and contractors (e.g., price trends). As most companies coordinated their requirements when possible, these contracts were in many cases agreed centrally. This, however, requires systems that are able to exchange data. Infrastructural and multi-site solutions therefore will be required to support this purchase coordination. Also, the role of purchasing in the *product development* process was mentioned as increasingly important and required attention (for example in the form of the development, implementation and maintenance of a standard component library, or the support of Early Supplier Involvement — ESI). Furthermore, IT should support the evaluation of the effectiveness of these decisions by means of *performance measurement and assessment* tools.

Finally, the dispersed nature of many companies requires effective and efficient *communication functionality* not only between local plants and central purchasing departments, but also between local plants mutually and between various departments that are involved in purchasing decision making.

Decision Making Situations. Whereas present-day systems mainly address the 'transactional' aspects of purchasing (e.g., requisitioning, ordering, reminding, and recording order confirmations, receipts, and invoices), new systems should focus on supporting those (initial) purchasing activities that are carried out to implement the relationship within which these transactions can be carried out. This implies that new IT applications should address so called *new task and modified rebuy situations.*[12] Compared to straight rebuys, these type of buying situations are characterized by a higher degree of uncertainty, relatively unknown suppliers, and mostly involve (at least partly) unknown and changing specifications (e.g., one company mentioned change control as an important requirement).

[12] This well-known typology of purchasing situations — new task, modified rebuy and straight rebuy — was developed by Robinson, Faris and Wind in 1967.

In repeat buy situations, most organizations were looking for improved means to optimize the repeat process (e.g., by introducing new ordering methods, by improving or extending their MRP package or even implementing new ERP software, and by implementing EDI links with suppliers).

Decisions Models. Contemporary decision models — i.e., models of the way in which various outcomes and alternative decisions are connected to each other — are, a.o., reflected in the data that are gathered in the initial purchasing activities. In new task and modified rebuy situations, buyers mostly search more extensively for information to reduce the increased uncertainty that they experience.[13] This is reflected in many examples such as the need for data on price movements in the supply market, historical performance data, cost breakdowns, enhanced requests for supplier offers, detailed market data, product specifications, budgets, local inventory levels, production and marketing plans, expenditure data, etc.

The consequence hereof is that purchasing systems should be able to accommodate all these data (once expressed as a need for *enhanced registration* possibilities), and to make these data accessible (possibly in a consolidated way). Therefore, there is also a growing need for *flexible management reporting* capabilities (like flexible queries, aggregation, cross sections, and selection), not only for use in initial decision making but certainly also for performance reporting and assessment.

Furthermore, there is a manifest need for *analysis, evaluation and simulation tools* to answer many of the "if ... then ..." questions related to the new purchasing decision characteristics indicated in Table 1-2. From the case studies this is sometimes mentioned explicitly, and sometimes the need for a Total Cost model was expressed to be able to evaluate decision alternatives.

Management. As Van Weele also indicates (Van Weele, 1994, p. 26), decision making in new task situations (and to a lesser extent in modified rebuy situations) is "characterized by extensive problem solving and becomes protracted because various disciplines, ..., will probably assert their influence". Because of this more complex nature of the decision making process, purchasing management requires tools for allocating and managing the *resources* involved in the various processes. Furthermore, purchasing *processes* need to be managed so that they finish both timely and effectively.

[13] This shift was nicely phrased by Claessen in an AT&T and Philips Telecommunications report from 1988 entitled 'Purchasing management information: From procurement information towards information procurement'.

A second manifest (management) requirement relates to the management of the extensive collection of *data* used and generated in initial purchasing respectively performance measurement. This implies that new IT applications should have an extensive data base at their disposal, suitable for recording all these different data. Closely related to this data management issue is the growing need for accessibly storing (unstructured) text frequently found in these purchasing activities. Buyers and management are swamped with journals, brochures, books, flyers, etc. and the information contained in these *documents* should be made accessible.

Finally, just as there is a growing need for *flexible management reporting* capabilities for use in performance reporting on key supply factors, this need also exists for reporting on key purchasing factors. This need is mainly inspired by purchasing's new 'glass house' status, which implies that purchasing management has to justify its purchasing practices and performance towards general management.

SUMMARY

In this chapter we focused on the determination of the new directions in which supportive IT systems in purchasing should evolve. The conclusion was that any new applications of IT in purchasing should be more supportive to so called initial purchasing tasks in new task and modified rebuy situations, and the evaluation of the effectiveness thereof (i.e., performance measurement and assessment). The characteristics of these application areas further called for (1) analyses, evaluation and simulation tools; (2) flexible reporting and query capabilities; (3) communication functionality; (4) resource and process management tools; and (5) extended data and document management functionality. These requirements serve as the starting point for the next part of the research.

DESIGN

—5

Initial Purchasing in Industry

In their efforts to reduce the time to market (TTM) significantly, to reduce development costs, and at the same time to attain 'first time right' designs, Fokker Aircraft among other things initiated a project focusing on supplier relations (the SURE project) in 1994. Part of the SURE project involved the definition of the processes with which supplier relations were implemented. A clear distinction was thereby made between the initial phase resulting in a contract with a supplier, and the subsequent execution of the contract activities (both during product development and actual production). Activities that were part of the initial phase were, (a) the choice of a *supplier strategy*, involving, a.o., the determination of the desired supplier type and relation, single or dual sourcing, selection criteria, etc., (b) the definition of multi disciplinary *requirements* (involving engineering, financial, logistic, product support, quality, commercial requirements, etc.), which was named the Supplier Requirements Specification (SRS), and (c) the *sourcing* of suppliers (i.e., supplier qualification and selection involving the requesting and evaluation of quotations, and contract negotiations). During the initial purchasing activities, the make-or-buy decision is actual, as quotations, for instance, can reveal facts that can change the outcome of this important decision.

CHAPTER CONTENTS

Both in practice as in the literature, purchasing is often subdivided into several phases. The example at the beginning of this chapter is only one of many examples that exist. In this chapter we focus on the initial purchasing phase. After all, one of the major conclusions in the previous chapter was that new applications of IT in purchasing should be more supportive to this phase in new task and modified rebuy situations. Therefore we analyze these tasks in more detail in this chapter. We hereby provide a first insight into the answers to research questions four, seven, and eight, viz. what exactly are purchasing decisions that should be supported, how are these decisions reached (i.e., the processes going with these decisions) and how are these purchasing processes managed? This chapter thereby does not only build upon existing theories, but also upon a detailed analysis of purchasing's responsibilities during a product development project at Philips Medical Systems.

INITIAL PURCHASING IN NEW TASK SITUATIONS

Until now, we have still made use of the intuitive understanding of the concept of purchasing. Before we can find out, however, how to support initial purchasing with automated information systems, it is necessary to define clearly what we understand by 'purchasing' and — within this frame — by 'initial purchasing'. We also give a brief explanation on what is meant by new task situations, because this term indicated the type of situation requiring support.

A Definition of Purchasing

As was stated already in the first chapter, every company depends on external sources to meet a variety of organizational needs. Purchasing is thereby responsible to assure that supply actually takes place and that contracted activities are actually carried out so that the needs are satisfied. From a dictionary,[1] we can also find that supply stands for providing something that is needed, to provide things to someone for use, to satisfy a need. A source is thereby defined as the means of supply, the place from which something comes.

Within the context of industrial purchasing a multitude of activities can be distinguished. Additionally, various definitions of purchasing and related terms like buying, obtaining, procurement, acquisition can be come across in the literature. From the same dictionary again, we can find that to purchase is to buy, to obtain something by paying money, to become the owner of

[1] Longman Dictionary of Contemporary English (New Edition). Longman Group UK Ltd., Harlow, Essex, UK, 1987.

something by means of effort or planning. To procure something means to obtain something by effort or careful attention. To acquire means to gain or come to possess something by one's work, skill or action, often over a long time. As we can deduce from these last definitions, the main difference between these terms is not in the objective, but in the means of achieving this objective. Furthermore, purchasing is the only term that explicitly refers to the transfer of money. Therefore, purchasing is taken as the central term in this dissertation.

In the special literature as well, several definitions can be found for terms like purchasing, purchasing management and procurement. Definitions thereby range from fairly operational (see, e.g., Heinritz, *et al.*, 1986, Baily *et al.*, 1990, Lester *et al.*, 1989 and Nijs, 1991) to definitions that have a more strategic content (see, e.g., Håkansson, 1982). Furthermore, a distinction can be made between definitions that focus on purchasing objectives (see, e.g., Pooler, 1992 and Van Weele, 1994) and definitions that focus on the activities that are carried out in purchasing (such as, e.g., Webster *et al.*, 1972 and Baily, 1987).

It may be clear to the reader, that it is not easy to provide a well-considered definition of the concepts of purchasing and initial purchasing; well-considered taking into account the objective of this research. In the next sections therefore, the most important concepts are put in perspective.

Purchasing and Contracting Out. First we have to distinguish between the buying of goods, materials, equipment, supplies, merchandise and components of which the buying organization actually becomes the owner, and the contracting out of processes and activities (sometimes referred to as services). In the true sense of the word (referring to the definition in the dictionary), *purchasing* only refers to products (e.g., materials, goods, components, merchandise, finished products, equipment and supplies). Only in these cases the buying organization becomes the owner of the items that were bought. These are supplied by an organization that normally is referred to as a *'supplier'*. When *contracting out* processes or activities, it should be noted that the organization that contracts these out pays for the processes and activities that were carried out (or: the service that was provided). Or even more specific, the contracting organization pays for the use of capacity over a specific period of time. It does not pay to become the owner of these resources (as was indicated in the definitions from the dictionary to be essential for purchasing or buying). The contracted organization is mostly referred to as a *'contractor'*.[2]

Although the subject matter of purchasing and contracting out differs, in this study we assumed the nature as similar in that they both try to satisfy the needs of the organization by making use of external resources (suppliers respectively contractors). For sake of argument we will therefore only use the term 'purchasing' for both purchasing as well as contracting out, and 'supplier' for both suppliers as well as contractors.[3]

Purchasing's Objective. In the special literature several objectives of purchasing are mentioned. Ribbers (1980) states that "purchasing is responsible for enabling planned production to take place". Baily (1985) mentions the objective of "meeting production plans, sales programs or operating needs". Van Weele (1994) states that purchasing must satisfy the needs of "the primary processes of the business, their maintenance and management". A broader view is adopted by Fearon *et al.* (1993) when they stated that purchasing must enable the achievement of organizational goals. Although typical of the development in the view on purchasing, this last statement is not a very discriminating statement. More specific is the condition of cost-effectiveness in achieving customer satisfaction. Van Weele (1994) refers to this condition when he states that purchasing should take place "at the most favorable conditions for the organization".

From the foregoing it is clear, however, that there is some agreement on the objective of purchasing in that it aims at the cost-effective satisfaction of the needs for goods and services.[4] It thereby makes use of external resources. Several authors thereby discriminate between various groups of (internal) customers such as, e.g., production (or in more general terms, the primary process), its maintenance and management. However, as any process depends upon inputs and resources that potentially (for whatever reason) might be purchased from a supplier, or for the fact that (part of) a process

[2] Please note that the purchasing (and consequently also the maintenance and disposal) of equipment and the employment (including selection, training, etc.) of personnel are more and more replaced by leasing respectively hiring temps. In this way, the *purchasing*, maintenance and disposal of equipment and the employment of personnel become activities that are *contracted out* to contractors such as lease companies and employment agencies.

[3] The distinction between purchasing and contracting out, and supplier and contractor, is a somewhat artificial distinction anyway. In most present-day cases, when actually purchasing a product, the customer also pays for several services provided to him by the supplier (e.g., some customer-specific engineering activities). In this respect, purchasing and contracting out can be seen as two ideal types.

[4] Please note that this responsibility is sometimes (partly) outsourced itself.

potentially could be contracted out to a contractor, the internal customer can be any process, even purchasing itself (to give only some examples, purchasing also needs writing materials, computers, etc. and also might consider hiring temps via an employment agency or contracting a market research or consultancy bureau).

Purchasing's Function. According to general system's theory, a system performs its function by providing the desired outputs to its customers (which are part of the environment). In our context, these outputs are the desired goods, materials, equipment, supplies, merchandise and components or the desired service. Ribbers (1980) as well mentions "the provision of the required materials and parts" as the function of purchasing.

It is important, however, to note again that these goods and services are actually supplied by suppliers. In this study, this primary process engaged in the actual supply of goods and provision of services is referred to as 'supply'. Purchasing is thereby responsible that supply actually takes place in a cost-effective way. Baily (1985) calls this the "arranging for the supply", Pooler (1992) calls it to "ensure economical supply". Håkansson (1982) also mentions the "securing of the resource inputs of materials, components, and equipment into the business" as purchasing's function. Nijs (1991) calls this function the "securing of the ... availability of products". It should be noted, however, that generally not the whole supply chain is directly relevant from a purchasing perspective, but only that part towards which purchasing actions are required and useful.

A Definition of Purchasing. From the discussions up to now, we define purchasing as a function that aims at the cost-effective satisfaction of the organizational needs for goods and services by making use of external resources (see Figure 5-1).

In Figure 5-1 we distinguish between purchasing and supply as discussed above, and also identify the three major conditions within which purchasing has to perform its function, viz., (1) supply possibilities, (2) needs, and (3) conditions (such as cost-effectiveness). Actions of purchasing therefore are also primarily directed towards influencing these three aspects, i.e., (1) making use of the capabilities of external resources, (2) influencing the needs, and (3) influencing the conditions.

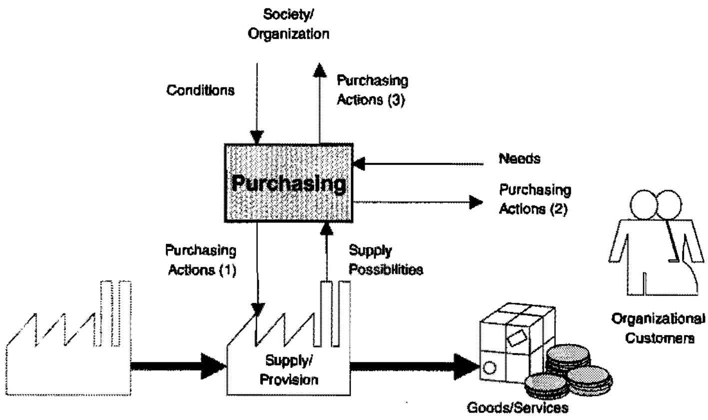


FIGURE 5-1. Purchasing and supply in perspective.

Purchasing — Phasing and Activities

Next to the many terms, concepts and definitions, there are also many descriptions of purchasing available from the literature that focus on the activities and phases that can be recognized in purchasing.

In a publication by the Dutch steering group Purchasing Large Companies, in which organizations such as Akzo, DSM, Hoogovens, Philips, PTT Telecom, Shell, Stork Industries, and Unilever are represented, the purchasing process was subdivided into three stages, viz., a product- and markettechnical phase, a commercial phase, and an administrative phase (Steering Group Purchasing Large Companies, 1987, p. 22). The activities that are part of each phase are summarized in Table 5-1.

It was remarked, that the whole of this process, i.e., all three phases, would only be performed in 'initial buying situations' (or new task situations) and that in most cases not all three phases would be visible.

Following his involvement in the publication referred to above, Van Weele (1994, p. 9) grouped the product- and market-technical and commercial phases into the initial or tactical purchasing phase. The administrative phase was renamed the (operational) ordering phase.

TABLE 5-1. Purchasing Phases and Activities

Phases	*Activities*
Product- and Markettechnical Phase	1. Identification of Need
	2. Establishing Specifications
	3. Establishing Required Quantities
	4. Market Research and Identification of Potential Suppliers
	5. Requesting Quotations
	6. Evaluation of Quotations
Commercial Phase	7. Negotiations
	8. Definitive Selection of Supplier
	9. Contract Writing
Administrative Phase	10. Ordering and Order Monitoring
	11. Invoice Control
	12. Evaluation and Feedback

Source: Steering Group Purchasing Large Companies, 1987, p. 22.

Initial purchasing was further subdivided into three stages, viz., (1) *specification*, which involves the definition of product specifications, change management, and Early Supplier involvement (ESI), (2) *selection*, involving activities such as pre-qualification, requesting quotations, and the final selection, and (3) *contracting*, involving negotiations and contract writing. The ordering phase of purchasing involves the actual ordering, order monitoring (i.e., open order monitoring, trouble shooting, receiving and quality inspection), and the evaluation and follow-up (involving the settlement of claims and disputes, vendor rating and record keeping) (see Figure 5-2).

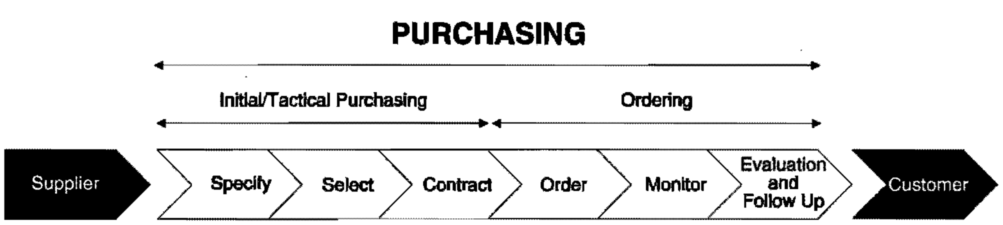


FIGURE 5-2. The purchasing model of Van Weele. *Source*: Van Weele, 1994, p. 9.

Although many other alternative phasings exist, their are of course similarities. First, most experts in the field generally agree upon the activities that make up the purchasing process, although their phasing might differ (if only in terminology).[5] Second, and most importantly, most publications make a distinction between the activities that are carried out before the actual order, and the activities that are carried out after (and including) the actual ordering. This first phase we refer to as 'initial purchasing'.

New Task Purchasing Situations

It was already remarked, that the identified steps would not be carried in every case. Only in 'initial buying situations' (or new task situations) it would be necessary to carry out all steps. In general, three typical buying situations are distinguished (Robinson, *et al.*, 1967):

1. *New Task Situations.* This case involves the first time purchase of a product or service. Both product and supplier are mostly unknown and the whole situation is characterized by uncertainty.
2. *Modified Rebuy Situations.* These cases mostly involve changed product specifications, or a new supplier. This situation is less uncertain than the new task situation.
3. *Straight Rebuy.* In practice, most cases involve straight rebuys, or repeat buys. It entails the purchase of a known product from a known supplier. The uncertainty is low, as all terms and conditions have already been agreed upon earlier.

Initial purchasing and new task situations are seemingly closely related to each other, as initial purchasing activities are mostly most extensively carried out and thus most visible in new task situations. In the next chapter we come back to the issue of different purchasing situations in more detail.

INITIAL PURCHASING IN PRACTICE

Now that the concept of initial purchasing has been demarcated, we turn to the practice of initial purchasing. This is done by discussing a case study that was carried out at Philips Medical Systems' headquarters in Best, the

[5] For some examples, we refer to the standard text books in the field like Leenders and Flynn, 1995 (p. 16), Fearon, *et al.*, 1993, Zenz, 1994 (p. 37), and Heinritz, 1986 (p. 43).

Netherlands. The case study involved the identification and detailed description of initial purchasing activities.

Philips Medical Systems

Philips Medical Systems — one of the product divisions of multinational Philips Electronics — is a world wide operating supplier of diagnostic imaging equipment for medical purposes, related therapeutic equipment, and of accompanying services to hospitals. Together with General Electric, Siemens and Toshiba, Philips Medical Systems (PMS) belongs to the four largest suppliers of medical equipment in the world. The medical systems and components PMS makes can be grouped into the following five groups, viz., X-ray, magnetic resonance, ultra sound, computed tomography, and radio therapy. World-wide, Philips Medical Systems counts c. 10,000 employees of which c. 2,200 are employed in Best, the location of the head office of Philips Medical Systems.

One of the main building blocks of the PMS organization are the so called Program Management Groups (PMG), of which eight exist. PMG's are responsible for product marketing, development, production and service support of medical equipment. PMG's are organized into Program Management Centers (PMC). Philips Medical Systems Nederland B.V. (PMSN) in Best is such a PMC that accommodates four PMG's among which X-Ray Systems Best (XSB). XSB had a number of 641 employees budgeted (June 1993) and had yearly net sales of c. US$ 236 million and a yearly purchasing turnover of c. US$ 180 million. This implies that c. 75% of the yearly turnover was spent on purchases (1991). XSB produces medical systems that were grouped into three product lines or so called program groups named Remote Control (for examination of stomach and bowels), Cardio Vascular, and Surgery. The program group Cardio Vascular is by far the largest program group of these three.

XSB was organized into the following areas: (1) Program Management, (2) Purchasing, (3) Integral Logistics, (4) Manufacturing, and (5) Service Technical Support. The Predevelopment and Systems Technology department finally coordinated the policy towards systems architecture, technology and imaging quality. Purchasing's main activities were initial purchasing and ordering. The operational ordering activities were organized according to the three program groups and were closely related to the activities of Integral Logistics. Some of the employees were responsible for coordination of all purchasing activities.

The L-ARC Project

In this chapter the initial purchasing activities that took place within PMSN are described on the basis of a detailed case reconstruction of a development project, the L-ARC project.

L-ARC. A L-ARC is part of the geometry-segment of an X-ray diagnostics system and its main function is to hold an X-ray tube and an image intensifier or sensor. The price of such an X-ray diagnostics system as a whole roughly ranged from US$ 0.5 - 1.5 million, depending on the exact configuration. There were two major variants of the X-ray diagnostics system. The mono plane variant only had one X-ray tube and an image intensifier. The bi-plane variant had two X-ray tubes and image intensifiers which gives a doctor more possibilities in concurrently making various projections. Furthermore, less contrast fluid is needed and the quality of the projections improves. The L-ARC was used for the second channel in the bi-plane variant of the system. Roughly, c. 50 bi-plane variants were sold every year.

The project was initiated by Marketing aiming at improving and securing the market share in the market for cardio vascular systems. The potential customers in this market look at service, specification (e.g., performance, user friendliness and image quality) and design of a medical system. In particular in the last two areas, the L-ARC played an important role. The L-ARC project mainly addressed geometry aspects and mainly involved mechanical developments. A very important condition for the project was to develop the new L-ARC without raising the price the customers had to pay for the system.

Systems Management. In describing initial purchasing, the Systems Management procedure of Philips was taken as starting point. This procedure prescribes the phases and baseline documents of a development project. Within Systems Management seven phases are distinguished, viz. (0) Policy, (1) Feasibility, (2) Overall Design, (3) Detail Design, (4) Engineering - Integration - Testing - Market Preparation, (5) Start-up Production - Market Introduction, and (6) Production - Sales - Service. In Figure 5-3 the overall view over the L-ARC project is depicted, reconstructed from the above-mentioned sources.

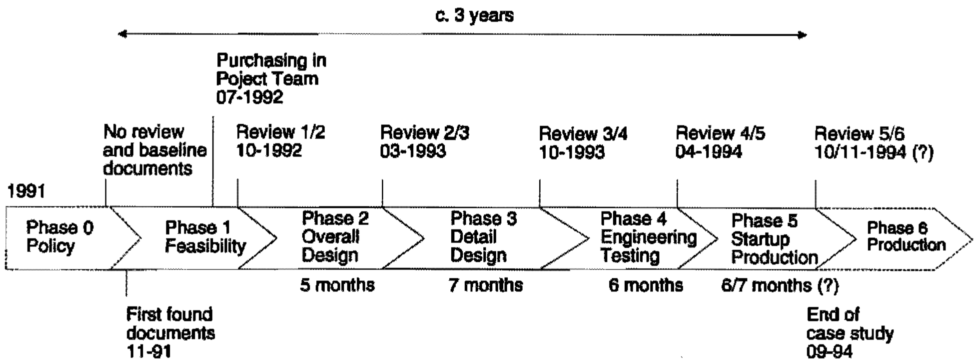


FIGURE 5-3. The phases in the L-ARC project.

Purchasing's Involvement in the L-ARC Project

In the next sections the purchasing activities that took place in phases 0 - 4 are discussed. These discussions are based on interviews (with people from Project Management, Marketing, Development and Purchasing), and desk research (involving the Project File (containing minutes, reports, notes, specifications, etc.), baseline documents, procedures, and some personal project files).

Phase 0/1 — Policy/Feasibility. Since no formal review 0/1 was held, the exact transition between phase 0 and 1 could not be specified. Review 0/1 was almost always combined with review 1/2. In this phase only a few disciplines were actively involved (Marketing, Development, and later on Application and Design). Phase 0/1 took over one year (although the exact start of phase 0 is not known). During Phases 0 and 1, purchasing activities that were carried out were:

1. *outsourcing*, involving make-or-buy discussions;
2. *product design*, which included the definition of policies concerning the design of the product as well as the actual definition of the product specifications itself;

3. *sourcing,*[6] including both the definition of general policies regarding the sources to use (like statements concerning the limitation of the number of suppliers) and sourcing itself;
4. *project management,* involving the organization, planning, progress control and staffing of the project as well as the definition of procedures to be used during the project;
5. *operational management,* implying the issuing and follow up of concrete work orders and assignments; and
6. *project purchasing,* involving the purchasing of products for development purposes within the context of the project.

Phase 2 — Overall Design. In this phase various disciplines were involved in the Project Team (meanwhile consisting of 22 people). Phase 2 took about six months. In Phase 2, purchasing tasks that were identified were:

1. *outsourcing,* involving the reassessment of existing trade off's used in make-or-buy questions;
2. *product design,* including evaluation of both product design and supply possibilities, sometimes resulting in redesign proposals (mostly cost related);
3. *demand planning,* which involved the forecasting and planning of the total number of L-ARC's required;
4. *sourcing,* implying the identification of potential suppliers, requesting and evaluating quotations, selecting and contracting suppliers, and setting up a list of preferred suppliers mainly for products designed by Philips;
5. *project management,* mainly involving the organization of project activities, progress control, and the definition of new procedures to be used during the project;
6. *operational management,* implying the issuing and follow up of concrete work orders and assignments; and
7. *project purchasing,* involving the purchasing of products for development purposes (e.g., parts for use in test models).

[6] Vollman, *et al.,* (1984) defined sourcing as finding sources of supply, guaranteeing continuity in supply, ensuring alternative sources of supply, and gathering knowledge of procurable resources (p.148), which resembles Van Weele's selection step (1994, p. 11).

Phase 3 — Detail Design. Phase 3, Detail Design, again took about six months. In this third phase, purchasing tasks were:

1. *outsourcing,* involving the reassessment of earlier make-or-buy decisions;
2. *product design,* including evaluation of both product design and supply possibilities, sometimes resulting in redesign proposals and engineering changes. This phase, however, also involved the evaluation of prototype parts supplied by suppliers;
3. *demand planning,* which appeared to be a difficult task, again involved the forecasting and planning of the total number of L-ARC's, but now also included the planning of closing orders for parts (and spare parts) used in the previous version of the L-ARC;
4. *sourcing,* implying the identification of potential suppliers, requesting and evaluating quotations, selecting and contracting suppliers (for instance, based upon the final test results), and setting up a list of preferred suppliers. In this phase, in contradiction to the previous phase, this was done for products of which the specifications were more or less dictated by the supply market;
5. *project management,* mainly involving the organization of project activities, progress control, and the definition of new procedures to be used for the first series of L-ARC's and subsequent startup of production (e.g., how to handle engineering changes and new releases, how to order, etc.);
6. *operational management,* implying the issuing and follow up of concrete work orders and assignments; and
7. *project purchasing,* again involving the purchasing of long lead time parts for use in the assembly test models.

Phase 4 — Engineering / Integration / Testing / Market Preparation. Phase 4 was the last phase of the L-ARC project that was taken into account in the case study. Phase 4 of the Systems Management Procedure took c. five months. In this phase, most complex and critical items were already almost fully specified and their repeat supply arranged for by purchasing. Activities that remained in this phase were:

1. *product design,* however, only involving the specification of the relatively simple items and packaging materials that were not defined yet, and the handling of the stream of small engineering

changes resulting from continuous design and prototype evaluations;

2. *demand planning,* still involving the continuous adaptation of quantities to more recent forecasts, and the following up of supply chain consequences;
3. *sourcing,* involving the activities already identified before, however, now only carried out for those (mostly relatively simple) items not allocated yet;
4. *project management,* primarily concerned with the definition of quality assurance and engineering change procedures during regular production of the L-ARC;
5. *operational management,* again involving the issuing and follow up of concrete work orders and assignments within the larger project plan; and
6. *project purchasing,* involving the purchasing of the short lead time parts for use in the assembly test models.

ANALYSIS — PURCHASING TASKS

When analyzing the case study described above, we can distinguish three types of purchasing related activities during the L-ARC project, viz., (1) activities that are carried out that directly involve issues related to *supply* (like the specification of the product, the suppliers that were going to supply these products, etc.), (2) activities that more or less relate to the organization, planning and execution of the *project* and its activities (like the definition of procedures, staffing decisions, project planning, project coordination, etc.), and (3) activities involving the *purchasing* of products and parts for project purposes. These three types of activities are summarized and discussed below under the headings of initial purchasing, purchasing management, and project purchasing.

Initial Purchasing

Tasks in Initial Purchasing. The first type of activities are also those activities that are similar to those mentioned in the literature as being part of the initial purchasing phase. We therefore refer to them as initial purchasing tasks which includes (1) outsourcing, (2) product design,[7] (3) demand planning, and (4) sourcing. When we look at the identified initial purchasing tasks, it is clear that they are all aimed at the preparation and implementation of a seamless supply process. To clearly understand the decisions that have to be taken during initial purchasing we take a closer look at supply.

Elements of Seamless Supply. Supply — when considered a system — consists of so called temporary elements and more permanent elements (see, e.g., In't Veld, 1988, p. 19). The temporary elements (e.g., concrete items) 'flow' through the system, mostly undergoing various kinds of value-adding transformations in the supply process so that they will ultimately satisfy the needs. The transformations (or activities) are carried out by the relatively more permanent elements that make up the structure of supply (the supply base, e.g., suppliers, distributors, etc.) (see Figure 5-4). This supply base is normally subdivided into several so called supply tiers or echelons. First tier suppliers are those suppliers that directly supply the buying organization; second tier suppliers supply first tier suppliers, etc. thus forming a so called 'supply pyramid' (see Womack, *et al.*, 1990, p. 146).

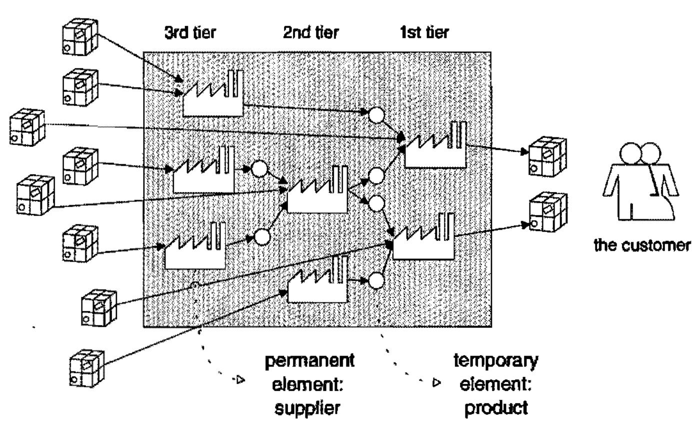


FIGURE 5-4. Temporary and permanent elements of supply.

[7] Or in more general terms, the specification of needs, either goods or services.

Both type of supply elements are subject to purchasing if it is expected to implement a seamless supply process. Thus, purchasing is responsible for (1) defining the required temporary elements (through outsourcing, product design and demand planning activities) and (2) for defining the supply base that will carry out the required activities (through sourcing activities).

Examples of the purchasing decisions related to temporary supply elements are the technologies underlying product specifications, the width and composition of the bought-in assortment, the product and service specifications — in various supply tiers possibly, etc. Examples of decisions related to the structural elements of supply (the supply base) are, e.g., the number of supply tiers to consider, the number of sources to deploy (e.g., the decision on single, dual, or multiple sourcing), the required characteristics of individual suppliers (sometimes referred to as 'supplier profile'), and individual suppliers that are going to supply the organization (possibly in several tiers, see, for instance, Industry Snapshot 5-1).

INDUSTRY SNAPSHOT 5-1. Supplier Selection Across Several Tiers.

During the L-ARC project, the supply base for wiring harnesses was again examined. It involved second tier component suppliers, and first tier wiring assembly shops. A request for quotation was thereby sent to the preferred component suppliers supplying the first tier supplier for PMSN's previous L-ARC version, and also to the component suppliers resulting from PMSN's own supply market research. Based upon the submitted quotations the initial list of five potential suppliers was reduced to a short list of three. After testing samples, the list of three was further reduced to two suppliers that were qualified as preferred suppliers. The information on these two suppliers were then communicated to the first tier supplier that was free to start its own negotiations based upon this information. The first tier supplier then selected one to do business with, primarily based upon price differences as their competencies did not differ significantly.

Purchasing Management

Tasks in Purchasing Management. The second type of purchasing related activities that were identified in the case study are not as much focused on the elements of supply, but focused on the elements of the project. These are the managerial activities addressing the definition, organization and staffing of the project as a whole, the definition of working methods and procedures for use in the project, and the planning, initiation and progress control of project tasks and activities (on various levels of detail).

We refer to them as purchasing management tasks, earlier referred to as (1) project management (on the project task level) and (2) operational management (on the level of individual activities) (see Figure 5-5). As only one project was taken into account in the case study, multi project management issues were not encountered, but it is clear that these issues are of course present in industry. This would imply an obvious extension to the figure below.

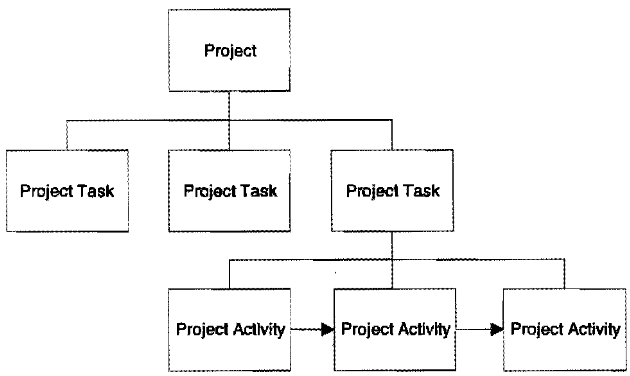


FIGURE 5-5. Projects, project tasks and project activities.

Purchasing Procedures. Although most of the tasks described above are of a generic nature, i.e., not specifically related to the field of purchasing, the task of defining the purchasing procedures to follow in the project is not. Examples of this task are the design and definition of procedures for the involvement of suppliers during product development (known as Early Supplier Involvement (ESI) or residential engineering), ordering, coding, engineering change and release procedures, authorizations, and quality assurance and inspection procedures. These procedures govern the actual execution of project activities and subsequent repeat activities.

Project Purchasing

Positioning Project Purchasing. One of the project tasks encountered during the case study was project purchasing. This task involved all activities pertaining to the purchasing of parts and products for development purposes (e.g., for use in development test and assembly test models).

In essence this can be interpreted as a purchasing task in itself, potentially involving all purchasing and purchasing management tasks discussed before. Project purchasing may involve, for instance, the definition of needs, the search for and selection of a suitable supplier and the ordering of the product, but also the allocation of the responsibility for these activities to persons within the organization and the progress control of the activities. In this way, project purchasing can be seen as a recursive instance of purchasing in a sense that it also aims at the cost-effective satisfaction of the organizational (development) needs for goods and services by making use of external resources.

Therefore, the discussions on purchasing and purchasing management tasks also hold for project purchasing.

Purchasing in Perspective

The purchasing process, tasks, activities, function and department. Although all of the individual tasks and activities mentioned in the previous sections are important, none of them matters if the process as a whole does not produce value for the customer. Therefore, as was also argued by Hammer and Champy (1993) in their well-known book "Re-engineering the Corporation", we have to focus on the process. A process is thereby defined as a set of activities that, taken together, produce a result of value to the customer. In this case, this customer is the (mostly internal) customer of the purchasing process (traditionally referred to as the 'requisitioner') that is in need of the goods or services. As Hammer and Champy put forward, any organization should organize its work around its processes. In this way, the service provided by the process can be enhanced and the customer can, at any time, question the status of the process (and get an answer!)[8].

This is obvious when looking at the close interaction in which the tasks identified above are carried out. For example, sourcing decisions are influenced by product specifications, and — the other way around — specifications are also defined based upon the possibilities and limitations of the supply market. Therefore, decisions made with regard to both supply base and product design are continuously evaluated on their mutual

[8] In this way the resources involved in product design, outsourcing, sourcing, demand planning as well as the management of these tasks are really responsible and *answerable* for the cost-effective satisfaction of the organizational needs for goods and services by arranging supply from external resources.

consequences. Furthermore, sourcing or product design policies may be reverted to if no suitable design and/or supply alternatives are left as a result of, e.g., too strict policies.

Because of this interdependent (or coupled) nature, the activities during initial purchasing are mostly carried out in an iterative fashion (see, e.g., Erens, 1996, p. 165). In most cases these interdependencies are dealt with in a multidisciplinary team approach as was also the case in the L-ARC project. Furthermore, central project files were kept. These are both forms of 'organizing the work around the process'. However, this multidisciplinary team approach also implies that the persons involved came from different functional disciplines. This brings us to the role of the functional purchasing department in the process as a whole.

The encountered (concurrent) interdependency between the identified tasks is also a major characteristic of concurrent engineering (CE), an approach to the concurrent design of products and processes taking into account all life cycle perspectives. Cleetus (1992) thereby states that decision making in CE is characterized by large intervals of parallel working by all life cycle perspectives, synchronized by comparatively brief exchanges to produce consensus. A similar way of working was observed during the L-ARC development project.

Looking at the process from this perspective brings us to the conclusion that the product design task in itself is not a task of the purchasing function, but rather that the purchasing function is one of the life cycle perspectives that play a role in the total process of satisfying the organizational needs for goods and services from external resources. The purchasing function thereby evaluates the resulting (intermediate) specifications on their effect on supply, and provides product development with knowledge on the possibilities and limitations that outsourcing of (part of) the product brings about (Erens and Van Stekelenborg, 1993, pp. 37-53). It is, however, only one of the many life cycle parties that are involved in product design (see Figure 5-6). A similar discussion can be followed for the role of the purchasing function in the outsourcing and demand planning task.

Based upon the foregoing, the prime responsibility of (initial) purchasing is *sourcing*.[9] Of course, next to this prime responsibility, purchasing is also required to critically review, evaluate and constructively contribute to decisions regarding product design, outsourcing and demand planning. From this perspective, purchasing can also be viewed as the function that, a.o., represents the supply perspective in various processes.

[9] Please remember also that the definition of purchasing also explicitly stated that purchasing aims at the cost-effective satisfaction of these needs by *arranging supply from external resources.*

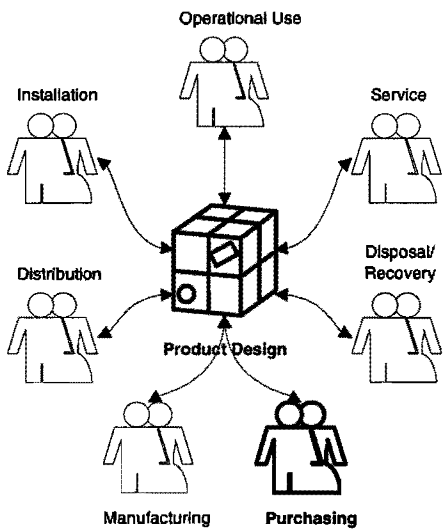


FIGURE 5-6. The role of purchasing in product design.

Finally, in every organization the organizational responsibilities are defined differently. This may cause that the purchasing department does not carry out all activities related to the purchasing function, not to mention the purchasing process. This was also remarked earlier by Van Weele (1994) when he argued that the scope of the purchasing function is far wider than the activities of the purchasing department, and that many other disciplines might be actively engaged in the buying of goods and services (p. 28).

Structuring Purchasing Tasks. Based on the reflections upon the case study, we can conclude that purchasing tasks in product development projects can be subdivided into (see Figure 5-7):[10]

1. primary purchasing tasks (i.e., both the definition of sourcing policies and the actual sourcing activities to ultimately come to sources that will supply the required goods, e.g., supply market research, supplier qualification and selection, and contracting);
2. secondary purchasing tasks (i.e., representing the supply perspective in decisions concerning outsourcing, product design

[10] We hereby do not take into account project purchasing activities.

and demand planning by critically reviewing, evaluating and constructively contributing to these decisions);

3. specific purchasing management tasks (i.e., the task of defining policies including procedures for the way in which purchasing tasks are carried out); and
4. generic purchasing management tasks (i.e., generic multi project, project and operational management tasks taking into account the cost-effectiveness criterion).

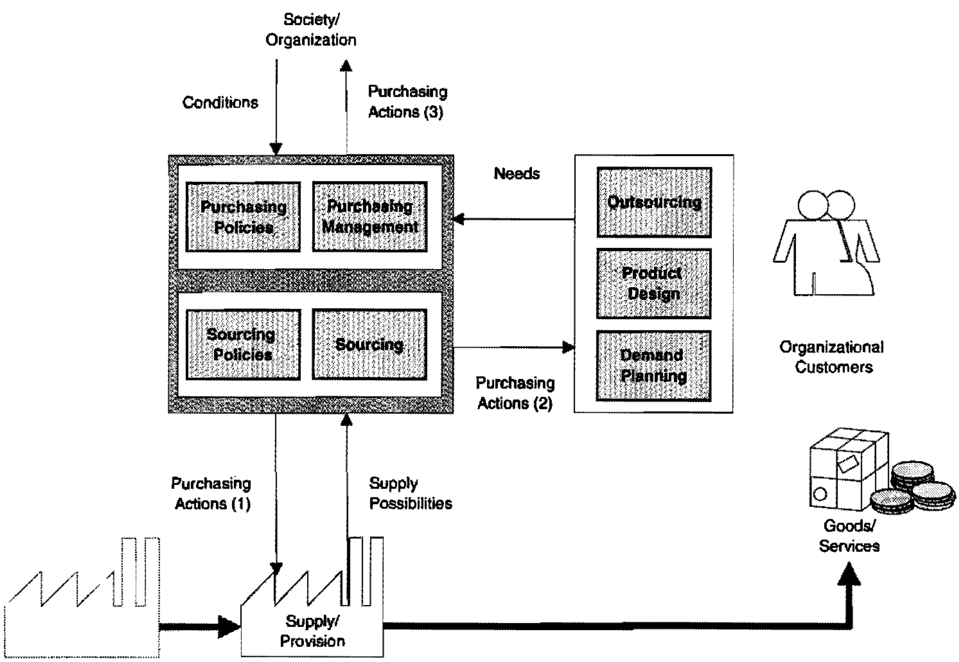


FIGURE 5-7. Purchasing tasks during product development in perspective.

ANALYSIS — THE PURCHASING PROCESS

In many cases during the L-ARC project, part of the sourcing task took place in an 'off-line' fashion as it were. For instance, at the start of some of the sourcing activities during the project, a list of preferred suppliers was already known. It should be noted, however, that although the sourcing activities resulting in this list were not directly visible in this particular project, these suppliers have of course been audited and qualified at an earlier stage. For other items, however, the sourcing task did have to be carried out full-fledged.

It seems that although all purchasing activities have to be carried out once in order to actually effectuate supply, they do not always have to be carried out specifically for an item required in a particular project. To understand this phenomenon, we now discuss the nature of purchasing as a process in a more detailed fashion.

Events Triggering the Purchasing Process

The most prominent event triggering the process is the notice of a need (of the customer) that possibly should be satisfied by goods and/or services supplied by external resources. The motives for outsourcing can be manifold, e.g., it could be for reasons of efficiency (e.g., lower prices), but also for reasons such as better quality products, higher service levels, increased flexibility, lacking internal know-how or capabilities, or a temporary capacity-shortage, to name a few. A major characteristic of this type of event is that there is an existent need that has to be satisfied (and possibly in the short run). This means that supply of the required goods or services (and the purchasing activities to get supply going) will take place directly related to this specific need. Examples of this type of event are the prototypes and test model parts that were required during the L-ARC project.

This explicit statement of an existent need, however, is not the only possible event triggering the process; as purchasing is also responsible for monitoring its environment (especially in a pro-active mode), triggers do not only result from needs that the internal customer has explicitly made known to purchasing, they also might originate from events such as perceived future needs (as is the case for most of the activities carried out during the L-ARC project), or changes in the current supply or the potential supply market (e.g., poor performance of the current supply base, or the emerging of new suppliers). Changes in the organization as a whole, or even in the environment defined by political, legal, economic, technological, ethical and social factors might also trigger the process. Finally, time itself can be a trigger that can possibly initiate the process (to give an example, a supply market research activity can be initiated based upon the fact that it has been several years since the market was scanned for new suppliers).

These triggers then might initiate purchasing management[11], purchasing and supply activities that, taken together, may finally produce a result of value to the (internal) customer.[12] The possible events triggering the purchasing process are depicted in the following figure.

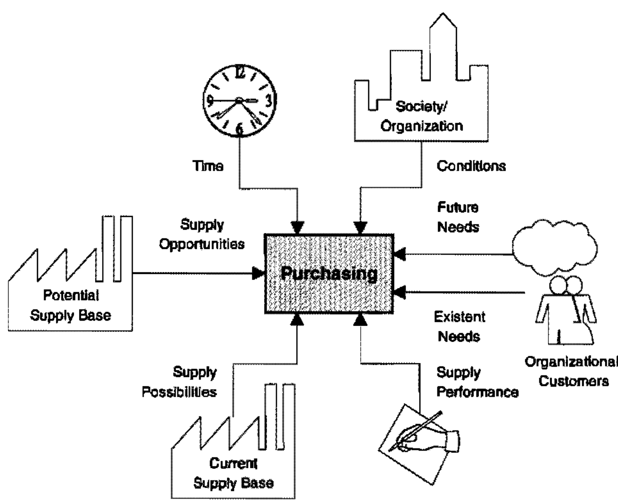


FIGURE 5-8. Events triggering the purchasing process.

Multiple, Time Shifted, and Simultaneous Purchasing Processes

Considering the many (new, modified, or similar) needs arisen during the L-ARC project, it is obvious that many purchasing processes took place simultaneously in every phase of the development project. However, these purchasing processes of course do not all start at the same moment, or even

[11] The reason for integrating purchasing management activities into the process, is the fact that it is impossible to carry out any purchasing task before it is defined how this task should be carried out (which procedure to use), by whom it is to be carried out, how much time is permitted to be invested in this particular case, when it should be concluded, etc. For the customer, however, this is of no concern; these activities are just part of the process that ultimately should provide a value adding result.

[12] A very important implication of this point of view is that — from the customer's point of view — there is actually no such thing as a purchasing *process* since it is this 'ensemble' that determines the ultimate value of the result of this complete process to the internal customer; the one from which purchasing management, purchasing and supply derive their ultimate right to exist. For sake of clarity, however, we will not use this subtle distinction.

in the same phase. This was also already remarked when discussing the sourcing of more or less standard and fairly unimportant items in phases 3 and 4 of the L-ARC project. Purchasing processes are therefore initiated shifted in time during the project (see Figure 5-9).

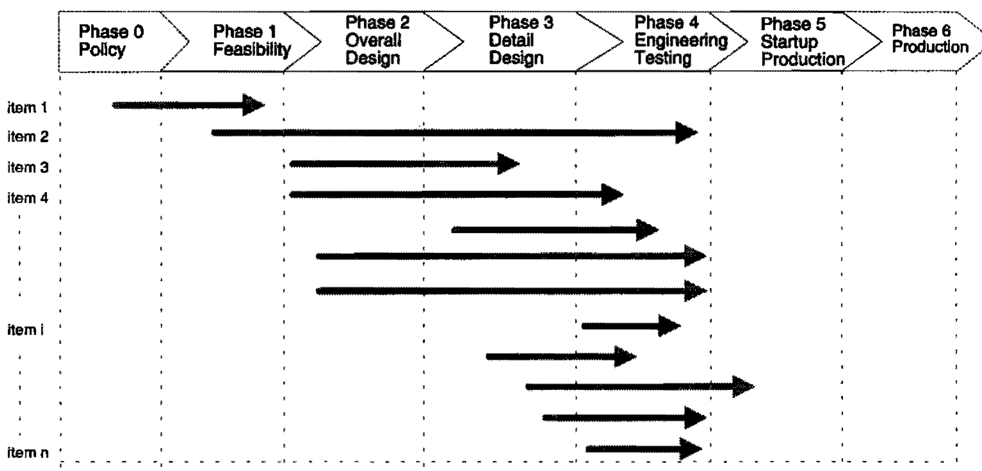


FIGURE 5-9. Multiple, time shifted, and simultaneous purchasing processes during product development.

Many of the existing phase models and process descriptions of purchasing only address a single purchasing process, excluding the more realistic viewpoint on purchasing processes discussed here.

From this discussion it is also clear why the purchasing management tasks identified in this chapter are important in assuring the performance of the process as a whole.

Anonymous and Case Specific Purchasing Processes

If we reconsider the discussions on possible events triggering the purchasing process, we can see that there is only one particular event — namely that of an explicit and existent customer need — that more or less directly results in the satisfaction of the needs of the internal customer. All other cases result in purchasing activities that are not directly related to such a specific and current customer need.

When the process is triggered by a specific and existent need of an internal customer, some of the purchasing decisions that have to be made to arrange supply might already (partly) be taken, whilst others might still have to made. An example of this phenomenon is the contract; a contract allows requirements to be handled both efficiently and effectively. The requirements can be satisfied by just placing a call-off. In other cases, however, extensive purchasing activities are required to arrange supply.[13]

The same also holds for purchasing activities that maybe were required to contract this supplier. An example of this is the decision, which supplier to select in a particular case (independent of each specific recurring customer need). In some cases a list of already qualified (or 'approved') or even 'preferred' suppliers can be available, whilst in other cases market research and supplier audits will specifically have to take place. In the last situation, the purchasing process will require much more time of course. It seems as if several of these intermediate results can be defined in the purchasing process in order to more efficiently and effectively handle cases that are presented to purchasing.

The foregoing can be interpreted as being analogous to the customer order decoupling point (CODP) in logistics theories (see Hoekstra and Romme, 1993). This CODP distinguishes the customer order specific from the more 'anonymous' activities in production (i.e., activities that are not related to a directly identifiable customer order). We hereby introduce a similar concept to structure purchasing processes. The CODP in purchasing distinguishes between activities based upon a specific case presented by an (internal) customer resulting in the actual supply and satisfying of the internal customer's needs, and anonymous, prognosis-based and pro-active activities. These pro-active activities can be seen as 'producing' data that can be used in making the final decisions when an actual need of an (internal) customer needs to be satisfied by supply. This can be interpreted as producing an 'inventory' of data, analogous to the inventory of raw material, semi finished or even finished products at the CODP in logistics. For each type of event and type of case presented to purchasing such a decoupling point can be identified (see Figure 5-10).

For instance, in the event of perceived future needs (the L-ARC case), the different types of cases within the development project might all have different decoupling points depending upon their characteristics. Well-known decoupling points in purchasing, for instance, are the Approved Supplier List (ASL) enabling the effective and efficient execution of supplier

[13] E.g., in the construction industry, when temporary consortia or so called virtual organizations are set up to create value to the customer.

selection activities, a standard contract clause library enabling the effective and efficient drawing up of a contract, and the contract itself enabling simple and fast repeat buys.

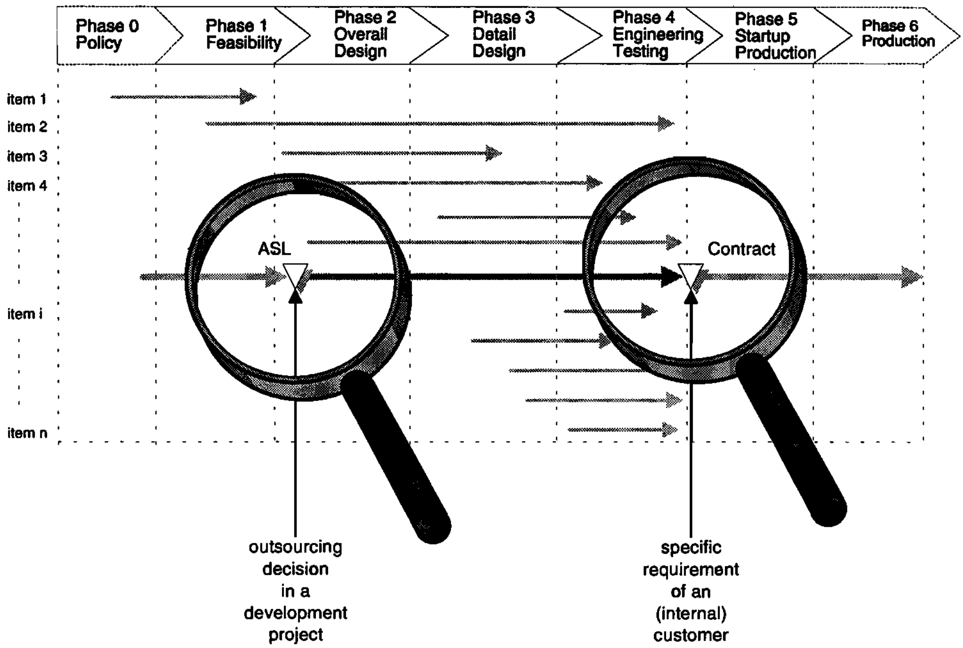


FIGURE 5-10. Examples of decoupling points in the purchasing process.

It is clear that purchasing — in its attempts to improve its performance — therefore will try to decide on most of the supply issues beforehand in an often in the literature suggested 'anticipative' or 'pro-active' mode based on prognosed needs. Thus, purchasing tries to shift the decoupling point downstream, and carries out so called 'preparatory' or 'anonymous' activities aiming at providing case independent indications to the purchasing decisions that have to be made when an explicit need comes around. However, it is evident that this is not always possible and depends, for instance, on the novelty of the cases that are presented to the purchasing process. This subject of different purchasing situations is discussed in more detail in the next chapter.

SUMMARY

In this chapter we discussed the initial purchasing phase, as one of the major conclusions in the previous chapter was that any new applications of IT in purchasing should be more supportive to this phase. Several lessons have been learned, particularly through the case study that was carried out at Philips Medical Systems. Firstly, initial purchasing tasks can be subdivided into purchasing and purchasing management tasks. Secondly, sourcing can be considered the prime task in initial purchasing. We also discussed the nature of purchasing as a process and concluded that there are many different and successive events that can trigger purchasing processes, and that in reality there are many purchasing processes running simultaneously. Subsequently we also made a difference between customer 'order' specific and anonymous purchasing activities. From these discussions it has become clear that there are many different modes in which purchasing carries out its prime tasks resulting in different lead times, different starting moments of the purchasing activities within the project, etc. In the next chapter we continue with this discussion, when discussing the various typical situations and cases that purchasing has to deal with in initial purchasing.

—6

Typical Purchasing Situations

The Procurement and Logistics department at NAM — a Shell Operating Company responsible for exploration and production of oil, gas and condense in the Netherlands and the Dutch continental shelf — operates a detailed supplier qualification procedure. This procedure consists of seven steps grouped into an introduction (evaluate qualification request, determine provisional Product Group and Product Group Classification, collect information, and evaluate documentation) and qualification phase (financial evaluation, technical evaluation, and acceptance). The procedure has to be carried out taking into account possible situations. If a supplier is not admitted to NAM's supply base yet, the full procedure has to be carried out taking into account the Product Group Classification (PGC). This PGC indicates the risk that NAM takes if the purchased product or service in question were to fail (technically and/or commercially). If a new product, with a higher PGC than those for which a supplier has already been admitted to NAM's supply base before, is to be sourced, the qualification only involves carrying out the additional steps required for the higher PGC. Finally, if a product, with a lower PGC than those for which a supplier has already been admitted, is under consideration, only the product itself and not the supplier has to be judged (*Source*: NAM's Contractors Qualification System, 1993).

CHAPTER CONTENTS

In the previous chapter we already identified that there are many different cases that have to be handled by purchasing, all with their own characteristics and all resulting in different ways of handling them. In the introduction of this chapter yet another example of the relevance of different purchasing situations was presented. In this chapter we discuss this aspect of purchasing in more detail. We thereby mainly go into research question five, i.e., the question of what typical decision making *situations* can be identified in contemporary industrial purchasing. At the same moment we indicate the way in which purchasing processes take place in these situations. In doing so, we first briefly discuss some existing typologies of purchasing situations. Then we again turn to the industrial practice of purchasing and describe various purchasing situations at the Nederlandse Aardolie Maatschappij, a Royal Dutch/Shell Operating Company.

TYPOLOGIES OF PURCHASING SITUATIONS

"Theory? Right ..., But We Are Different". As we have seen before, in practice there is no such thing as 'the' purchasing process. This conclusion, that there seems to be no one best way of purchasing that is applicable to all kinds of situations, conforms to the principles of so called contingency theories. These theories postulate that (1) there is no best way to organize, (2) any way of organizing is not equally effective; and (3) no universal management principles can exist (see, e.g., Galbraith, 1973 and Botter, *et al.*, 1994). Hence, it appears that only conditional statements applicable to certain kinds of situations can be put forth.

Typologies. To prevent the formulation of principles that are too general, so called typologies were developed. By way of typifying situations it is possible to formulate purchasing principles that depend upon the type of situation. Applying contingency theories enable the adoption of a differentiated approach to purchasing, and — to some extent — to take into consideration the variety of situations in real life industrial purchasing.

In the existing literature this has been recognized for a long time and a lot of typologies have been developed since. Many of these typologies, however, focus on the contingencies that are relevant for the relationship with the supplier. The existing literature thereby mostly defines ideal types of supplier-buyer relationships. These types are described in terms of aspects that are descriptive of the relation between the supplier and the buying organization (e.g., the power balance, the perceived closeness and commitment, the intensity of the relationship, the degree of mutual adaptation, trust and interdependence, the transparency of organizational boundaries, or the solidity of the relation). Examples of this type can be found abundantly in the literature (see, e.g., Hirschman (1970), Ford (1980), Håkansson (1982), Campbell (1985), Child (1987), Sako (1991), Lamming (1992), Croom-Morgan and Wilson (1993), and Kreuwels (1994)). Typologies that address the type of purchasing process in a particular situation are, on the other hand, rare. The most prominent are the Buygrid proposed by Robinson, Faris and Wind in 1967, the Purchasing Portfolio proposed by Kraljic in 1983, and Bunn's 'buying decision approaches', proposed in 1993.

The BuyGrid

A well-known typology of purchasing situations has already been discussed briefly in the previous chapter. This was the typology once developed by Robinson, Faris and Wind in 1967. This typology — or 'buygrid' as they call it — distinguishes between three typical buying situations, viz., the new task situation, the modified rebuy, and the straight rebuy.

These situations were distinguished mainly upon the basis of difference in their *novelty*, and the *uncertainty* connected with this novelty. Robinson and his colleagues furthermore argued that cases in which uncertainties are present, the situation is characterized by a high degree of *risk*, i.e., the outcome of the operation is uncertain. They argued that when the uncertainty in a situation increases, the purchasing process will be more extensive, and more organizational functions will be involved to cope with these uncertainties.

One of the major drawbacks of the buygrid is that it does not differentiate between the importance of, and possible consequences involved in a particular buying situation. This drawback was also identified by McQuiston in 1989. The purchasing portfolio of Kraljic does address this aspect. An advantage of the buygrid approach, however, is that it abstracts from specific commodities and that it addresses each case independently which allows us to focus on the purchasing process (which conforms to our approach until now).

The Purchasing Portfolio

In 1983, Peter Kraljic (at that time a director in the Düsseldorf office of McKinsey & Company, Inc.) proposed a by now widely used portfolio approach to purchasing based upon two factors, viz., (1) the *strategic importance* (or profit *impact*) of purchasing, and (2) the *complexity* of the supply market (or supply *risk*) (1983, p. 110). Profit impact can be defined in terms of volume purchased, percentage of total purchase cost, or impact on product quality or business growth. Supply risk is assessed in terms of availability, number of suppliers, competitive demand, make-or-buy opportunities, and storage risk and substitution possibilities (p. 112).

After assessing all of the company's purchased materials or components on these two variables, Kraljic states that the purchased goods can be positioned in the portfolio consisting of four categories: 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) (see Figure 6-1). This process is sometimes referred to as 'supply positioning'.

Kraljic then argues that each of these four categories requires a distinctive purchasing approach, in proportion to the implications of the category. Strategic items thereby require a more extensive purchasing process than noncritical items. Van Weele adds that depending on the segment of the portfolio, more or less extensive supply market information will have to be gathered (Van Weele, 1994, p. 121). Furthermore, Kraljic notes that the portfolio calls for regular updating as materials may shift categories as a result of, e.g., economic changes, (p. 113).

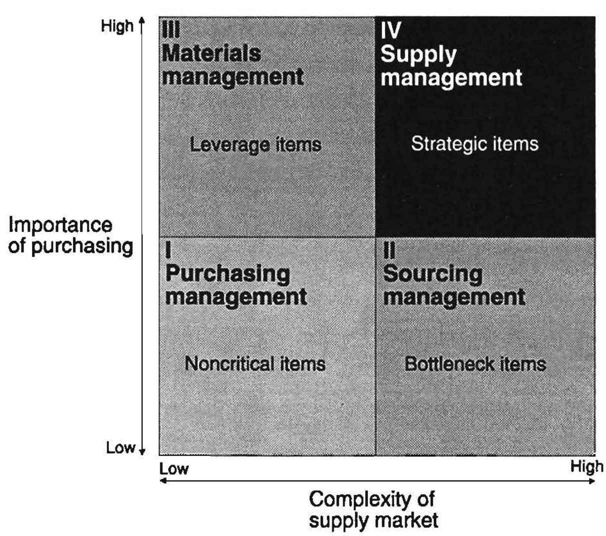


FIGURE 6-1. The purchasing portfolio. *Source*: Kraljic, 1983, p. 111.

Although Kraljic' purchasing portfolio takes into account both risk and impact, it lacks detailed translation to purchasing practices. It focuses the on the strategic implications of the various categories and only provides some indications on the practices required in the various categories. Furthermore, on the level of purchasing practices it is unclear how these practices are related to the characteristics of the category. Finally, Krajic' portfolio categorizes items and does not acknowledge the presence of different cases — possibly concerning the same item — that need to be handled by purchasing. The taxonomy proposed by Michele Bunn in 1993 particularly focuses on purchasing decision making in various cases. An advantage of her approach is also that she empirically investigated the relationship between situational characteristics and the decision making approach taken in those situations.

Buying Decision Approaches

In 1993, Bunn analyzed a large number of purchasing decisions in various situations. She thereby characterized the buying decision approach taken in each of these situations by:

1. the buyer's effort at scanning the internal and external environment to identify and monitor *information* sources relevant to the focal buying decision;
2. the extent to which the buyer makes use of formal and/or quantitative *tools* to objectively evaluate aspects of the buying decision;
3. the extent to which the decision making is prospective and considers the strategic objectives and long *term* needs of the firm; and
4. the extent to which the decision is *governed* by established policies, procedures, or transaction precedents.

Based upon these characterizing variables, Bunn identified six so called prototypical buying decision approaches, based upon differences in the above characteristics. She named these approaches (1) casual, (2) routine low priority, (3) simple modified rebuy, (4) judgmental new task, (5) complex modified rebuy, and (6) strategic new task.

Next, she tried to relate situational characteristics to the identified decision approaches. The situational characteristics that were taken into account were the buyer's perception of the purchase importance, task uncertainty (in Bunn's definition this involves both novelty and complexity), extensiveness of the choice set, and buyer power. The results are summarized in Table 6-1.

TABLE 6-1. Descriptions of Buying Decision Approaches.

	Casual	*Routine Low Priority*	*Simple Modified Rebuy*	*Judgmental New Task*	*Complex Modified Rebuy*	*Strategic New Task*
Situation						
• *Purchase Importance*	minor	somewhat	quite	quite	quite	extreme
• *Task Uncertainty*	little	moderate	little	much	little	moderate
• *Extensiveness of Choice Set*	extensive	extensive	narrow	narrow	extensive	narrow
• *Buyer Power*	little	moderate	moderate	moderate	strong	strong
Approach						
• *Information Search*	no	little	moderate	moderate	much	much
• *Use of Tools*	no	moderate	moderate	moderate	much	much
• *Proactive Focus*	no	superficial	high level	moderate	high level	purely
• *Procedural Control*	simple	standard	standard	little	standard	little

Source: Bunn, 1993, p. 47.

In another publication, exploiting the same empirical data, Bunn and Clopton specifically go into the use of information sources in the purchasing situations (1993). Information sources that were taken into account were, e.g., sales representatives, supplier employees, top management, product users, other inside employees, trade publications, catalogs or directories, sales literature, vendor computers, purchase records, and internal memos or reports. Based upon usage patterns of these sources, Bunn and Clopton identified five so called information source mixes, viz., (1) sales person centered, (2) internally limited, (3) specification seekers (i.e., mainly focused on external product data), (4) balanced searchers, and (5) aggressive searchers.

Similar to the approach taken before, Bunn and Clopton then continued with identifying situational characteristics of which importance and uncertainty were the ones corresponding to Bunn's earlier study.[1] The results are shown in Table 6-2.

TABLE 6-2. Information Sources and Process Characteristics in Various Situations.

	Salesperson Centered	*Internally Limited*	*Specification Seekers*	*Balanced Searchers*	*Aggressive Searchers*
Situation					
• *Importance*	low	low	low	high	high
• *Uncertainty*	low	low	high	medium	high
Approach					
• *Length of Process*	short	short	medium	medium	long
• *People Involved*	a few	some	some	a number	many

Source: adapted from Bunn and Clopton, 1993, p. 469.

Although these last two studies yield significantly more insight into purchasing processes and decision making, Bunn herself recommended a follow up case-based field study to refine the taxonomy she developed (1993, p. 53). Furthermore, as Bunn's study was of an empirical nature, the reasons behind a perceived prototypical buying decision approach or information source mix in a particular situation are not clear. Furthermore, from these studies it is also not clear whether a particular approach also yields the best results in a particular situation. This obstructs the discussion on the desirability and suitability of a particular approach. For these reasons, we again turn to the industrial practice; this time to look at different purchasing situations, taking into account the knowledge from the discussed typologies.

[1] It is relevant to note that Bunn and Clopton first started of with several contingencies that were later on taken together as they seemed to be related. An important relationship they found was the relationship between the uncertainty (which was only related to the need of the organization, and not to supply), and the length of the purchasing process.

PURCHASING SITUATIONS IN PRACTICE

In this section of the chapter we discuss a case study that was carried out at the head office of the NAM — the Nederlandse Aardolie Maatschappij (the Dutch Petroleum Company) — located in Assen, the Netherlands. The NAM study involved the analysis of various purchasing situations of materials, equipment and services that were outsourced, and the analysis of the corresponding purchasing processes.

The Nederlandse Aardolie Maatschappij

The Nederlandse Aardolie Maatschappij B.V. (NAM) was founded in 1947 and is responsible for exploration and production of oil, gas and condense in the Netherlands and the Dutch continental shelf. The roughly 3,000 employees of the NAM organization perform their activities on over 800 locations on land and on sea. The total gas production of the NAM in 1992 amounted to 65.5 billion m^3, corresponding with about 80% of the total production of gas in the Netherlands. The total oil production of the NAM in 1992 was 1.41 million m^3 corresponding with 45% of the total oil production in the Netherlands.

The NAM is an Operating Company (OpCo) of Shell within the sector of Exploration and Production (EP). EP is engaged in the search and production of oil and gas, on land as well as on sea. Shell OpCo's are, to a large extent, autonomous in planning and executing their activities. The activities of the OpCo's are coordinated by the Central Offices in The Hague and London. Shareholders of NAM are the Esso Holding Company Holland, Inc. and Shell Nederland B.V. Both companies possess 50% of the shares of NAM. NAM is part of the Royal Dutch/Shell Group and is being controlled by Shell Nederland B.V.

NAM consisted of a corporate organization, consisting of a Planning and Development Manager (PDM), a Finance Manager (FM), a General Affairs Manager (AM), and an Environment, Safety and Employment Conditions Manager (ESA). The operational Business Units and the Technical Services resorted under the Technical Manager (TM). All five managers reported to the General Manager of the NAM. The corporate organization and Technical Services organization were located in Assen. The five Business Units were Exploration (in Assen), Offshore (in Velsen), Groningen (in Hoogezand), Gas Land (in Schoonebeek) and Oil (in Schiedam).

Purchasing took place in various organizational parts of NAM. Most important player in the purchasing of materials and equipment, however, was TPL (Technical Services, Procurement and Logistics) which resided under the Technical Services organization. TPL was responsible for all material supply activities (including transport over land). From October 1992 up to and including September 1993, TPL placed over 30,000 (project, direct charge, and stock) orders for almost 100,000 items with a total value of NLG. 268,404,000.-. TPL made use of 164 agreements with their suppliers for ordering these items (September 1993). TPL was also responsible for transport. In the period from October 1992 up to and including September 1993, about 80,000 requests for transport services were made to TPL, which resulted in a total charge of about NLG. 36,000,000.-.

For services, the organization was much more fragmented. Players in the field of services were for instance TSF (Technical Services, Finance Business Support), TSW (Technical Services, Waste Management Coordination), FOS (Finance Office Support) and PIM (Planning and Development, Information Management).

Existing Classifications within NAM

Before we turn to the purchasing situations that were analyzed, we first briefly touch upon some divisions that were used within NAM. These were subsequently: (1) technology based categories (like the Materials and Equipment Standards and Code or MESC categories, product groups, etc.), (2) the Product Group Classification (PGC), and (3) the Procurement Targeting approach. For services, the Service Code Index (SCI) was just being set up.

Technology Categories. An important classification of all items (i.e., materials and equipment) within Shell's Materials (MA) organization is the MESC, i.e., the Materials and Equipment Standards and Code, covering almost 125,000 items. It has been in use within Shell for over 60 years. The MESC system consists of MESC main groups, sub groups and sub sub groups. These last sub sub groups then contain the actual items.

The MESC system consists of 99 main groups that are organized in 13 sections (A: Drilling and Production, B: Plant and Machinery, C: Transportation, D: Machinery Accessories and Instruments, E: Buildings, Tanks and Shop Equipment, F: Electrical, G: Tubular Goods, Valves and Fittings, H: Building Material, Metals and Hardware, I: Tools and Packing, J:

Paints, Oils, Chemicals and Laboratory, K: Medical, and L: Household, Office, Fire and Safety).

The NAM purchasing organization also made use of so called 'product groups', which were somewhat obscure sets of MESC items, mostly within one MESC sub sub group. A product group was identified by a product group code consisting of two digits and four characters (e.g., 09AJAA). The two first digits in most cases (however, not always!) thereby corresponded with the MESC main group identifier.

Product Group Classes (PGC). A classification that was specifically being used in the qualification, selection and evaluation process of NAM's purchasing organization is the Product Group Classification (PGC) based on the financial and technical risk belonging to a specific product group (resulting in four possible PGC's) (see Figure 6-2).

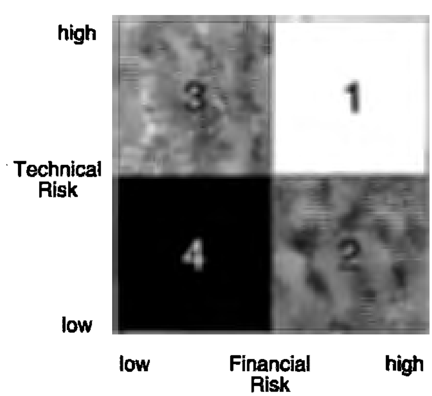


FIGURE 6-2. NAM's Product Group Classification (PGC).

Procurement Targeting. In Shell's Procurement Business Strategy (PBS) the Procurement Targeting approach was advised as an approach designed to elevate purchasing to a level of planned activity which concentrates resources on those areas which add value to the purchasing process through the adoption of differentiation in techniques. The approach is similar to Kraljic' approach discussed earlier and is based upon a categorization of items based on *risk* and *profit potential*. Risk thereby consists of *supply risk* (i.e., risks arising from the vulnerability of the business to the unreliability of the supply market) and *technical risk* (i.e., risks arising during and after installation). Profit potential is the degree of opportunity which exists for the purchasing process to contribute to company profitability (e.g., by reducing cost of ownership, improving the quality and a more efficient administration of the order).

All materials and services can be ranked as high or low in respect of risk exposure and profit potential. According to how they score on these two scales, materials and services would fall into one of four basic categories as shown in Figure 6-3.

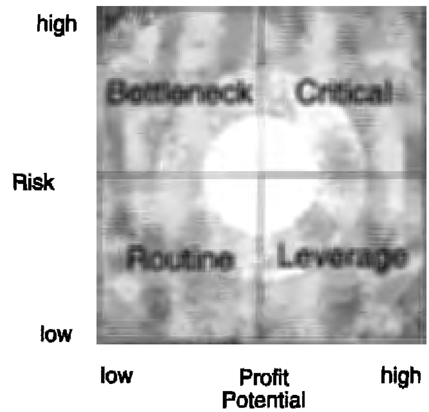


FIGURE 6-3. Shell's Procurement Targeting approach.[2]

For routine items the aim was to minimize the cost of acquisition by standardization, automation and, where practical, by contracting out the purchasing activity itself. For items in the bottleneck category, ensuring supply continuity was a key requirement. For leverage items, OpCo's aimed at maximizing commercial advantage. Purchasing of critical items demanded considerable time and effort in quality assurance, supply continuity and overall costs.

Service Code Index (SCI). For services, classifications were not yet common. However, NAM has to act according to the relevant procedures in the directive of the Council of the European Communities to "coordinate the procurement procedures of entities operating in the water, energy, transport and telecommunications sectors" when awarding contracts for supplies, works and services. Therefore, an index of service codes (the SCI) was being

[2] Please note that Shell's approach is similar to Kraljic' purchasing portfolio, but that it has swapped axes.

set up representing the services that are carried out either *by* NAM or *for* NAM. The Service Code Index consisted of four sections (A to D) related to the processes within NAM. Section A more or less related to management processes, section B to primary processes (i.e., exploration, production, facilities design and construction), section C comprised general services, and section D related to the so called resource processes (i.e., money, staff and information).

Materials, Equipment, and Services

In the NAM study a number of products (materials and equipment) and services were selected for analysis of the purchasing situations and processes. In consultation with TPL management, five products and five services were selected. These products were:

1. *Stationery*. This product group included products like memo-books, binders, cards, envelopes, files and writing pads.
2. *Supervisory Control and Data Acquisition (SCADA)*. SCADA systems are project materials used in NAM's plants. A SCADA can be seen as a kind of Management Information System with no direct impact on the process itself (this is done by the process control instruments SCADA derives its data from).
3. *Production Packers*. Production packers are so called well related materials, or drilling and production material.
4. *Surface Casing*. Surface casing is used during a drilling project.
5. *Furnaces*. Shell-designed furnaces are very expensive pieces of equipment of which only several (2 to 3) are needed every year (only in large new construction projects). These furnaces are used to dry the gas.

Services that were selected were:

1. *Hiring of temporary administrative staff*. The hiring of temporary administrative staff by making use of an employment agency.
2. *Removal Services*. Removals (e.g., in times of reorganizations when a lot of office furniture has to be moved and facilities have to be re-installed) were coordinated by FOS/12 (Accommodation Support).
3. *Software Development*. Software development by external sofware companies was coordinated by PIM/5 (Software Development and Operations).

4. *Cuttings Processing.* This involved the processing of drilling waste (e.g., cuttings) which was coordinated by TSW/4 (Waste Management Coordination, Data Management).
5. *Offshore Drilling Services.* Offshore drilling services (like the rental of offshore rigs and the hiring of drilling crews) were coordinated by TSF/4 (Commercial Services and Tenderboard Secretary).

Purchasing Situations and Practices

Now that we have briefly described the products and services under consideration, we turn to a discussion of the specifics of purchasing situation and the corresponding purchasing practices applied in that situation. These descriptions are based upon two semi-structured interviews of about one and a half hour each, that took place with each of the responsible buyers. The interviews first focused on the situational aspects (i.e., importance and uncertainties) and then on the practices in that situation.

Characterizing Purchasing Situations. In the interviews regarding the purchase situations, *importance* subsumed the potential consequences that might result from poor performance on quality or delivery (i.e., a total cost approach), the price level of the items or service, the yearly purchase turnover, and the possible benefits involved for the NAM (involving, e.g., competitive edge, innovativeness, etc.). A difference was thereby made between importance resulting from purchase price, and between quality and/or delivery related criticality.

Uncertainties were subdivided into internal (need or internal customer related) uncertainties, and external (supply market related) uncertainties. In discussing the perceived uncertainty in a particular situation, topics discussed were complexity (related to the number of aspects taken into account in decision making), dynamics, and predictability. Situations were then characterized in terms of their uncertainty, the source of this uncertainty (i.e., internal and/or external), and the subject of this uncertainty (i.e., quality and/or delivery).

Characterizing Purchasing Practices. The purchasing practices in each situation were described in a rather qualitative way. The focus in these descriptions thereby was on the various activities carried out as a result of a specific need, those carried out based upon forecasts of these needs, and those carried out relatively independently of such specific needs and forecasts. The plan depicted in Figure 6-4 thereby serves as a guide. In this plan, the various 'depths of penetration' of a specific need are indicated with subsequent numbers (① through ④).

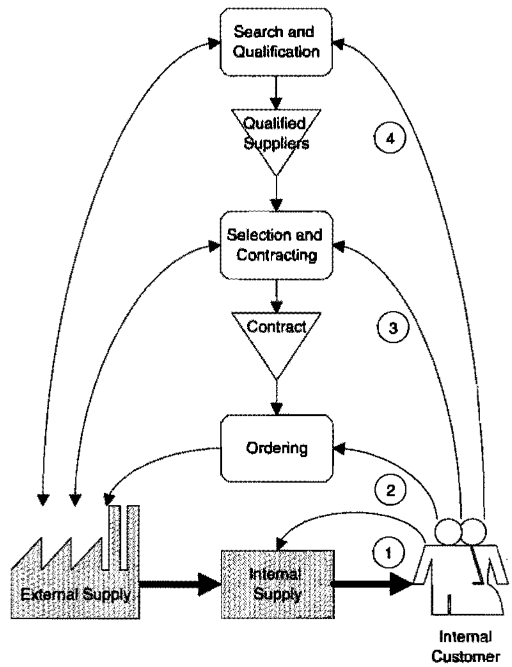


FIGURE 6-4. Purchasing practices characterized by depth of need penetration.

Situation ① can be characterized as 'provision from stock' where the internal customer makes its need known and the product or service is issued without the (direct) involvement of any external supplier. This practice limits the required coordination. The product or service has already been defined, and only the logistic aspects play a role. The second situation, indicated with a ②, is a situation in which the need is followed by a purchase order or call off. The contract conditions (and product specifications), however, have already been agreed upon before. So again, coordination is limited and involves only logistic aspects. In case ③, a supplier is selected from a list of qualified suppliers and contracted, based upon a specific requisition. This process generally takes a lot longer than the purchasing processes required in situations ① and ②. The process generally also involves coordination of product specifications, logistics, and commercial and legal aspects. Situation ④, 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.

Situations and Practices. A qualitative description of the purchasing situation and the purchasing practice in that situation is included below.

1. *Stationery.* Stationery primarily included low value items of which the consequences of non-availability and poor quality are negligible. Considerable uncertainties existed regarding the needs (both in terms of what and when). The NAM therefore standardized these items and kept these on stock. Requirements were made known to a local warehouse administrator who issued the goods from stock. On a weekly basis he counted local stocks and sent a requisition to the central purchasing department. This central department weekly placed an order for the required goods. New suppliers were contracted only occasionally. Main focus was on the efficiency of the operational purchasing process.
2. *Supervisory Control and Data Acquisition (SCADA).* SCADA systems were mainly important to the NAM as a result of their price (c. US$ 600,000 on average). They were, however, not essential for the execution of primary NAM operations. Uncertainties primarily related to the required functionality; it was not always clear what the customer expected. Other uncertainties were related to supply as several second and third tier suppliers significantly influenced the performance of NAM's first tier supplier. In satisfying the demand for SCADA systems, purchasing tried to pick up planned projects by keeping in close touch with the BU's. If projects were initiated, the project plan was communicated to purchasing. If SCADA's were required, suppliers were selected and contracted from a list of qualified suppliers. After contracting the supplier a bid clarification meeting was organized to explain the details of the project. Subsequent activities primarily involved the tuning of specifications with the supplier, supplier visits, and inspections.
3. *Production Packers.* When production packers are not according to specification, this may result in replacement and deferred production. Therefore, the quality of packers was considered the most critical issue. Most uncertainties were related to timing of the requirements as the drilling program changed frequently. Once every month, so called exhaust tables were produced and communicated to the supplier. These exhaust tables included both

current stock levels (at the supplier) and time phased demand, and were used by the supplier to keep his stock at the agreed safety level. Actual supply, however, took place based upon call offs (under contract) from the 'workshops' of the BU's. Contracting took place when the validity of the contracts that were in place ended.

4. *Surface Casing*. The significance of the quality of casing was comparable to that of the quality of packers. If specifications were not met, this could also result in deferred production. The repair of casing within the well could also take considerable time. Uncertainties were mainly caused by an unstable drilling program. Unlike the situation of production packers, however, there was also some uncertainty regarding supply (e.g., long lead times and lead time deviations). In satisfying casing demand, the Budget Data Book (summarizing drilling projects) was announced in the European Journal for OCTG (oil country tubular goods). Suppliers then contacted NAM and possibly qualified. Based upon specific drilling projects, suppliers were selected from this list of qualified suppliers and contracted for a 3 to 5 year period. Analogous to production packers, exhaust tables were produced. The resulting orders, however, were communicated to Shell and subsequently distributed over the suppliers that Shell has under contract. The supplied material was warehoused at the NAM. The actual requests of the local 'toolpushers' were forwarded to this warehouse.
5. *Furnaces*. When a furnace would not meet the requirements, a plant could be shut down, leading to deferred production, and possibly breach of contract. When a furnace would be delivered late at the site, the site contractor would be in problems and would put claims on the NAM. As these furnaces were unique, Shell-specific items, the specification was a source of uncertainties (also because the design was partly contracted out to an engineering company). Furthermore, as many supply tiers were involved in manufacturing furnaces, both quality and delivery was uncertain. Long term demand was communicated through prognoses. For each project a procurement plan was made. After the project requests from the contracted engineering company were approved, suppliers were selected and contracted from an existing list of qualified suppliers. After specifications were agreed with the contracted supplier, production could start. In between, inspections and expediting took place.

Regarding the services that were discussed in the study, the following brief explanation can be given:

1. *Hiring of temporary administrative staff.* The work to be carried out by temps was not of a critical nature. Most uncertainties were related to the unpredictability of the moment of demand. The type of work and the qualifications required were, however, known beforehand. Supply was abundant and stable and did not lead to any problems. In the long run, a 'position plan' or 'activity plan' was used for the planning of the need for temps and for budgeting. The corporate human resources department carried out the selection and contracting of employment agencies (mainly based upon rates). Local personnel officers received a list of contracted agencies and related rates. Based upon a specific, authorized instruction from a line manager, an employment agency would then be approached.
2. *Removal Services.* Removal services were not considered very critical. Uncertainties were primarily related the content of the work (as this could differ per project) and the number and timing of these projects. Removals were planned in consultation with the internal departments. The specification of the work to be carried out was then also assessed. The starting-date of a specific project was established in consultation with the foreman of the contracted removal firm. On the day itself the last consultation takes place between the remover and the NAM. The NAM worked with a limited number of regional removal firms, that were contracted on a yearly basis (mainly based upon rates).
3. *Software Development.* Software development had an increasing impact on the NAM. Quality (i.e., meeting requirements) was thereby considered the most important aspect, mainly because of the support that people expect from information systems. Timeliness was desirable but not as crucial as quality. Uncertainties were clearly related to the requirements the system should meet. Regarding delivery and lead times, most uncertainties were related to supply. Based upon the five year information plan, yearly activity plans were drawn up that defined the projects for the next coming year, together with suggestions for the 'make-or-buy' decision of these projects. Twice a year a list of preferred suppliers was drawn up and contract negotiations took place. For specific projects within NAM's activity plan, one of these preferred contractors would specifically be selected and contracted.

4. *Waste Processing*. The criticality of waste (cuttings) processing was mainly related to quality, because this needed to be done according to existing licenses and strict environmental laws and regulations. The only uncertainty that existed related to the timing and quantities that were offered. For a specific delivery to the contractor, pre-delivery information was provided two days beforehand. On a daily basis, NAM coordinated the daily quantities to be delivered to the contractor. In the longer run, work load was determined based upon drilling plans. For every project, the local drilling supervisor was provided with information on existing contracts to enable him to plan the required transports. These contracts were drawn up beforehand, and contractors were selected primarily based upon available licenses. This took place only occasionally, mainly as a result of changing regulations.
5. *Offshore Drilling Services*. The rental of offshore rigs and their crews was very critical. Poor quality could result in, e.g., dangerous situations (and injuries), rig down time, and deferred production. Poor logistic performance could result in not meeting demand resulting in high claims, breach of contract and thereby endangering partnership relations. As every well was unique, specifications of the drilling activities to be carried out changed from well to well. NAM depended on a few contractors, and lead times were long and starting moments unreliable. Furthermore, much uncertainty existed about the timing of drilling. In consultation with customers (i.e., the BU's offshore and exploration) and based upon the Budget Data Book, the level of work that needed to be outsourced was determined. The drilling sequence was indicative for the work load for the next 2 to 3 years. For specific offshore drilling projects the BU specified the criteria for the contract award. Based on these criteria (the so called 'hit list'), potential contractors would be identified, inquiries sent, and a contractor selected. The contractors in this small and well-known market were all known to the NAM, but no formal qualification took place.

Summary. The results are summarized in Table 6-3. In this table, the perceived importance and reason thereof are indicated, together with the perceived level of uncertainty, its origin, and the subject of this uncertainty. Furthermore, the focus and extensiveness of the process is indicated (based upon Figure 6-4).

TABLE 6-3. Characteristics of Purchasing Situations and Practices.

	Importance	*Reason*	*Uncertainty*	*Origin and Subject*	*Process Approach*	*Focus of Process*
Products						
Stationery	N	-	L	ID	①	D$
SCADA	M	$	H	IQ/ED	③	Q/D
Packers	H	Q	M	ID	②	D
Casing	H	Q	M	IED	①	D
Furnaces	H	Q/D	H	IEQ/ED	③	Q/D
Services						
Temps	N	-	M	ID	②	Q/D/$
Removals	N	-	M	IQ/ID	②	Q/D/$
Software	M	Q	H	IQ/ED	③	Q/D/$
Waste	M	Q	M	ID	①	Q/D
Drilling	H	Q/D	H	IQ/IED	④[1]	Q/D

N = noncritical, $ = purchase cost or efficiency, Q = quality, D = delivery, L = low, M = medium, H = high, I = internal, E=external.

[1] Suppliers are not formally qualified, but are all known to the NAM.

These results serve several purposes. First, they serve as illustrations of purchasing situations that can be come across in industrial purchasing. Second, they also provide additional insight in and confirm most of the propositions done in the earlier discussed typologies by Robinson, Faris, and Wind, Kraljic, and that of Bunn (and Clopton). For example, the *uncertainties* present in new task situations or modified rebuys that were also present in the SCADA, furnaces, software and drilling cases, clearly resulted in a longer purchasing process than in other cases.

Another finding relates to the way purchasing deals with uncertainty regarding the timing of the demand. In the case of stationery, no *forecasts* were used at all; in other cases (like with packers and surface casing) heavy use was made of forecasts. The effect of the *importance* of the various cases, however, is not directly clear, although both Kraljic and Bunn indicated the relevance hereof. Furthermore, the results indicate a relation between the subject of the uncertainties, and the *focus* in the process.

The described cases might also help us in understanding the reasons behind a specific practice in purchasing. This is the topic of the next sections of this chapter.

PURCHASING — DEALING WITH UNCERTAINTIES

A first important relationship that was found (again), was the relationship between the uncertainty in a specific case and the purchasing practice in that situation.

Remedies Against Uncertainty

Based upon Van Donselaar (1989), we identify two major (initial) remedies against uncertainty:

1. *take away* the uncertainties that are either related to the demand or supply, i.e., increase the *reliability* of the situation (e.g., standardize the assortment, keep items in stock, work with a well-known supplier, etc.); and
2. *deal* with the uncertainties, i.e., increase the *flexibility* of the situation (e.g., by anticipating and planning demand, by involving suppliers in the design process, etc.).

An example of the first remedy was the purchasing practice adopted in the purchasing of stationery. As purchasing in fact was confronted with much uncertainty regarding both the requirements and timing of demand (people just walk in to get what they want), purchasing standardized the available assortment and kept this limited number of items on stock. This is, however, a very particular situation that can be compared to a seller's market, where the consequences of not exactly getting what you want as a customer are insignificant. Furthermore, the costs of keeping stock were low because of the low value items that were involved. It may be clear, however, that this first remedy will only be applied when customers require instant delivery but are not willing (or able) to plan the requirements, and provided that specifications are stable (or at least not critical), and costs of stock-keeping are low (i.e., involving low value items). Other situations were dealt with by using the second remedy. Examples hereof were the contracting of a software agency before actual detailed specifications were available, and the purchasing of furnaces. Most of the situations, however, were dealt with in a hybrid way (e.g., the cases of surface casing and production packers, involving stock-keeping, well-known suppliers, and monthly demand planning).

The Role of Information and Communication

As one of purchasing's major tasks appears to be in managing uncertainties we now have a closer look at how this is done. First, relatively new and unique cases that were presented to purchasing in the NAM study, resulted in relatively lengthy processes, whereby initial purchasing tasks had to be carried out specifically for that case. These tasks were seemingly performed to try to take away any internal uncertainties regarding what had to be supplied, when and under what conditions, and any external uncertainties regarding the potential performance of the potential supplier.

Information and *communication* form the key to dealing with these uncertainties, as the uncertainties are mainly dealt with through the gathering of information on topics that are considered relevant but at that time still unknown or at least obscure, and by communicating plans and specifications towards suppliers in an attempt to improve their performance. Most of the uncertainties (mostly caused by unfamiliarity or obscurity) thereby could only be made more clear gradually during the process. Uncertainties therefore remained present until the goods were actually supplied, or the required activities (in case of a service) had actually been performed. This was visible in many cases and resulted, for instance, in intermediate supplier visits, expediting, inspections, etc. even close to the actual date of delivery.

Another finding was related to the subject of uncertainty. In many of the repeat buy situations, the uncertainties involved were only related to the timing of the deliveries. This resulted, for instance, in frequent inquiries about planning, forecasts, etc. In other cases, the uncertainties mainly involved the specification of the item or service (e.g., the furnace and software development cases). Most of the activities then concerned the coordination of these specifications between the NAM (or more specific NAM's internal customers) and the supplier.

Summary. From the above, it may be clear that much of the way in which purchasing takes place depends upon both the level and the subject of the uncertainty related to a particular case. It appears that purchasing is mainly engaged in dealing with uncertainties, and that the role of information and communication is crucial in this task.

PURCHASING — DEALING WITH SIGNIFICANCE

We have seen that purchasing has to deal with uncertainties. The way in which it actually does this, however, differed from case to case. Arguments therefore were related to the consequences and costs that were involved in a particular case. It seems that — next to the level and the subject of the uncertainty — the aspect of significance (based upon the potential costs and consequences involved) also plays an important role in explaining purchasing practices.

Cost Effective Purchasing

In discussing the purchasing practices in various purchasing situations, we first turn to our definition of purchasing. In the previous chapter we defined purchasing as the function that aims at the *cost-effective* satisfaction of the needs of the organization by arranging supply from external resources. The condition of cost-effectiveness has a significant effect on the way in which the purchasing process is carried out.

Effectiveness and Purchasing Risk. Two important initial tasks in the purchasing process concerned product design and sourcing. Product design thereby takes place taking into account various life cycle parties. On the one hand this is done to minimize possible costs in one of the product's life cycle phases as a result of poor specifications from that perspective. On the other hand this is done to maximize value through product functionality, appeal, competitiveness, ease of use, etc.

Furthermore, initial purchasing tasks are carried out to reduce the probability of non compliance (e.g., by sourcing an item from a well-known and well-performing supplier).

Finally, to ensure that the goods and services ultimately comply with the requirements and specifications (involving aspects such as quality, quantity, timeliness, place of delivery, and price), purchasing generally also takes action after the goods and services are ordered. Examples of such activities are order monitoring, supplier visits during contract execution, (intermediate) inspection, and expediting.

This implies that purchasing focuses on two complementary aspects of the needs it has to satisfy, viz., *pre-transactional*: to minimize life cycle or total costs, to maximize value over the life cycle, and to minimize the probability of non compliance, and *post-transactional*: to ensure compliance. These activities are all carried out to ensure effectiveness.

The foregoing leads to making a distinction between things that might go wrong, and the consequences of these things when they actually do go wrong. Together, this results in the expected consequences or purchasing risk related to a particular case to be handled by the purchasing process (see Figure 6-5).

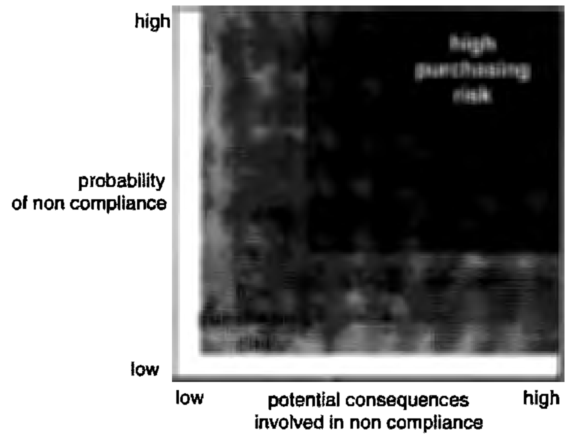


FIGURE 6-5. Compliance and consequences in purchasing.

Cost Effectiveness and Added Value of Purchasing. The above might explain the somewhat obscure role of the concept of 'importance' of a specific purchasing case found before, as it is the combination of both uncertainties and potential consequences that are important in assessing the amount of effort to be put into the process. This explanation is based upon the concept of cost-effectiveness.

Purchasing's effectiveness or added value can, a.o., be interpreted as the degree in which its efforts result in reduced purchasing risks. Conversely, it can also be interpreted as the degree in which it might increase value to the customer (e.g., through product functionality, appeal, competitiveness, ease of use, etc., primarily by bringing in supply market knowledge).

The purchasing resources invested in attempting to improve both these aspects should, however, be paying. This implies that although a case might be typified as risky, this does not immediately call for an extensive purchasing process as these efforts might not have any of the desirable effects. The expected reduction in risk or increase in value thereby should justify the resources invested in purchasing; these should be evaluated on their earning-capacity.

For instance, in the case of stationery, the probability of non compliance was negligible as were the potential consequences. The purchasing risk as a whole was therefore negligible. This situation therefore did not justify any significant additional purchasing resources, as improvements would only be marginal. This also explained purchasing's focus on internal efficiency in purchasing these goods. Initially, however, investments may be rewarding, as the improvements may be related to many repeat buys (which explains the often huge initial investments still done in these situations, e.g., in EDI projects, purchasing cards, etc.). In this case, for instance, the uncertainties related to the relatively unknown demand for stationery were handled by standardization of the assortment and stock-keeping. In the case of production packers, however, this solution would not have been cost-effective, as production packers were far more expensive and keeping them in stock would have been too costly. Therefore, purchasing tried to cope with the present uncertainties by making use of forecasts, and by expediting.

Relation to Total Cost Approaches. As we have seen, the purchasing function has to take into account any future consequences of their decisions while making these decisions. This is generally known as the Total Cost approach, although many other synonyms are known that in essence all address more or less the same issue (e.g., Total Cost of Ownership, Total Acquisition Cost, Least Total Cost, All-In Cost, Whole Life Costing, Life Cycle Costing).

The concept of Total Cost is based upon the understanding that price is only one of the many costs involved in buying. The approach describes all the additional (and most often hidden) costs that a company incurs when buying products or contracting out activities. In metaphorical terms, the concept can be depicted as an iceberg, of which price only represents the directly visible part floating above the water. But although it is clear that price is only a part of the total cost, it still is a part that may not be neglected in purchasing decision making. Other cost consequences of a specific purchasing decision, however, may be costs of transportation, inspection and testing costs, costs of scrap, idle time because of non availability, costs of keeping stock, costs of maintenance and energy consumption, costs of warranty, service and field failures, lost customer sales, returns, and costs of disposal to mention only some of the many examples (see, e.g., Burt (1991), Carr and Ittner (1992), Clemens and Smytka (1993), Ellram, (1993a and 1993b), and Janson (1989)).

In most publications, cost elements in the Total Cost approach are identified through an analysis of activities and life cycle phases which resembles the Activity Based Costing approach. In general, Activity Based Costing or ABC bases product costs on the costs of the resources consumed by the activities that are performed to make the product available to the customer. In the Total Cost approach this comes down to identifying all the activities related to the purchased item or service, and identifying or estimating the amount of resources that are consumed in these activities (together with their rates). The relationship between the specific purchased item or service and the exact activities that will be carried out for that item or service (including the amount of resources consumed in those activities), however, is not always very clear. This relationship is indicated with so called 'cost drivers' (e.g., the type of product, etc.).

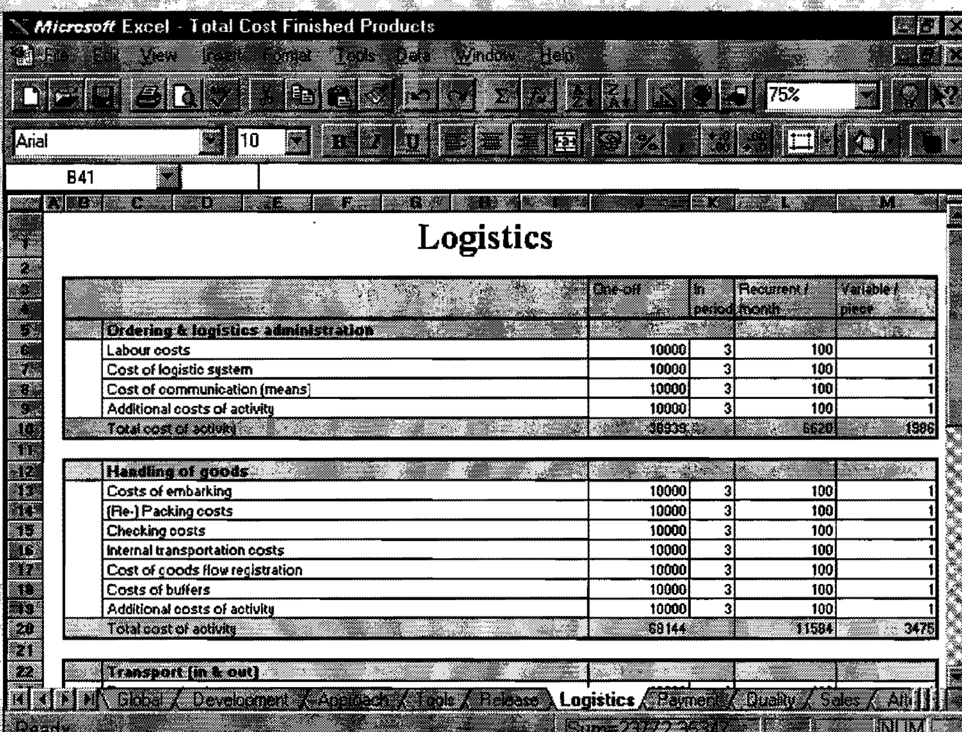
Next to difficulties in estimating and allocating the relevant share of downstream costs to a specific purchase decision, the Total Cost approach also does not take into account downstream 'values' that may result from a specific purchase. However, the introduced concepts do offer some relief in identifying the potential consequences of a particular purchasing decision. Until the identified difficulties have been resolved, however, most decisions are evaluated using, e.g., weighted point methods whereby the potential consequences of specific aspects of the buy are expressed in weightings (or even in costs, as Industry Snapshot 6-1 shows). Others make use of cost estimates (see Industry Snapshot 6-2).

INDUSTRY SNAPSHOT 6-1. The Price Comparison Module at the NAM.

When the NAM realized that through the years it had gathered valuable data on supplier performance, they decided to use this information not only as evaluation afterward, but to enhance their methods of bid selection. Therefore, the measured performance was expressed into cost elements (i.e., expediting and inspection cost estimates). These cost elements are primarily based upon former delivery and quality performance, but also took into account a commodity/complexity factor, Product Group Classification (PGC), delivery time, urgency, and order frequency. The adjusted 'total order cost', together with a so called Buyer Assessment of the bid, is then used in bid selection. In addition, this method aimed at the non restrictive evaluation of offers, complying with the (then) upcoming EC rules for procurement. Furthermore, by adopting this approach, the NAM reduced purchasing lead times through a relaxation of their tenderboard procedures.

INDUSTRY SNAPSHOT 6-2. TCO Models at Philips Electronics.

Philips Electronics uses Total Cost of Ownership (TCO) models for various product categories to provide buyers with a credible selection criterion for a product-supplier combination. These models identify cost elements, which are clustered into activities that are carried out in various organizational functions (like logistics, see Figure 6-6). The models thereby differentiate between one-off costs, recurrent costs per period of time) and variable costs (per unit). The data required to 'fill' the model is either gathered or estimated if unavailable. The resulting total costs of each of the alternatives is then calculated (by using a spreadsheet) and compared, after which a decision is made (Belonje, 1995).



	One-off	In period	Recurrent / month	Variable / piece
Ordering & logistics administration				
Labour costs	10000	3	100	1
Cost of logistic system	10000	3	100	1
Cost of communication (means)	10000	3	100	1
Additional costs of activity	10000	3	100	1
Total cost of activity	38939		6620	1986
Handling of goods				
Costs of embarking	10000	3	100	1
(Re-) Packing costs	10000	3	100	1
Checking costs	10000	3	100	1
Internal transportation costs	10000	3	100	1
Cost of goods flow registration	10000	3	100	1
Costs of buffers	10000	3	100	1
Additional costs of activity	10000	3	100	1
Total cost of activity	68144		11584	3475
Transport (in & out)				

FIGURE 6-6. Part of the 'logistics' activities and cost elements in Philips' TCO model for finished products.

SUMMARY

This chapter primarily discussed the perceived differences in purchasing practices and attempted to identify the reasons behind these differences. After discussing some of the useful typologies that are available in the literature, we turned to the practice of industrial purchasing. The major lesson learned in this chapter was that the purchasing process primarily focuses on dealing with purchasing risk, whereby purchasing risk was defined by the uncertainties and significance involved in the case to be handled. The focus of the purchasing process thereby depended on the source and aspect of the uncertainty (internal, external; quality, delivery, costs). Furthermore, it was argued that the efforts put into the purchasing process should be related to the expected reduction in risk for, or — conversely — increase in value to the customer. Finally, the role of information and communication turned out to be essential in dealing with uncertainty.

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Implications for Information Technology

AT&T Network Systems Nederland (now Lucent Technologies) was one of operating companies in AT&T's Network Systems Group responsible for the development, production, and sales of, a.o., telecommunication equipment and computer operated switchboards. The Corporate Procurement department was looking for a way to introduce the Purchasing Portfolio for OEM items. One of the major conclusions during the subsequent project was that the lack of (accessible and reliable) information was one of the major obstacles to be overcome. The systems that were in use only focused on the ordering of items. Next to the attention paid to the exact way in which purchasing cases should be positioned in the purchasing portfolio, the development of a supportive information system therefore also attracted much attention. Subsequently, a prototype of a portfolio management system was built using a simple spreadsheet. However, a more sophisticated system was perceived using a data base incorporating data on product groups, internal customers (Business Units), countries, and suppliers (Bosch and Heijen, 1995).

CHAPTER CONTENTS

We have now discussed the major lessons that were learned through the case studies at Philips Medical Systems and the NAM. These lessons were that purchasing tasks during initial purchasing can be subdivided into actual purchasing and purchasing management tasks, and that sourcing is the prime task during initial purchasing. We also discussed the nature of purchasing as a process and concluded that there are many different and successive events that can trigger the purchasing process, and that in reality there are many purchasing processes running simultaneously. Subsequently we also made a difference between case specific and anonymous purchasing activities. In the previous chapter we found that many different purchasing situations may exist in practice and that the purchasing process thereby primarily focuses on dealing with purchasing risk, whereby purchasing risk was defined by the uncertainties and significance involved in the situation.

But what are the implications of these conclusions for the support that can or has to be provided by information technology; and is it already possible to define any initial directives for systems supportive to initial purchasing and its management? In this chapter we propose five design principles (addressing both data and model characteristics) based upon the findings so far. These principles go into (1) the found differences in purchasing tasks, (2) the move towards more extensive purchasing practices, (3) the found differences in the familiarity with cases, (4) the diversity of cases that was encountered, and (5) the variability of the approach taken to handle a case, even during the execution of the process. The two chapters following this chapter then report on the development of two prototypes for sourcing based upon the design principles presented in this chapter.

DESIGN PRINCIPLE 1 — SUPPORT FOR PURCHASING TASKS

The distinction between initial purchasing and purchasing management tasks proposed in Chapter 5 gives rise to a similar distinction in the support that has to be provided by IT.

Specific initial purchasing functionality should thereby provide support for the tasks of (1) sourcing and (2) representing the supply perspective in outsourcing, product design (or need specification), and demand planning activities.

Managerial support should address the identified purchasing management tasks of (1) (multi-) project management and (2) operational management (on the level of individual activities).

Support for Specific Initial Purchasing Tasks

Model Requirements. The purchasing tasks that are carried out during the initial purchasing phase require support for:

1. *Sourcing.* Sourcing activities can be subdivided into activities focusing on the definition of sourcing policies, and activities involving the actual sourcing itself (within the defined policies). The policy-making task may require support from IT tools that enable the *definition* of high-level decision rules for various situations that 'govern' the more detailed decisions taken later in the process. These decisions can also be supported by tools that allow the *investigation* (analysis or simulation) of different, alternative sourcing policies. Furthermore, these rules need to be *communicated* throughout the organization, and related to tools that support decision on 'lower' levels of decision making (i.e., the actual sourcing task).[1] The actual sourcing activities may require support from tools that enable (a) the *identification* of potential goods and services, suppliers and supply markets (either in terms of region, country, supplier type, technology or commodity), (b) the *retrieval* of data on these goods and services, suppliers and supply markets (mostly involving data that is not internally available), (c) the *assessment* of the potential and suitability thereof using analysis, evaluation, ranking and decision making tools[2], and (d) the *recording* of (intermediate) decisions.
2. *Representing Supply in Outsourcing, Product Design and Demand Planning.* In Chapter 5 it was argued that purchasing is required to critically review, evaluate and constructively contribute to decisions regarding product design, outsourcing and demand planning. Therefore, purchasing plays a very important role in *providing information* on the opportunities and limitations the supply market brings about. Examples hereof are the use of a library of authorized purchased parts (and an indication of their mutual exchangeability) for use in product design, and the use of lead time and capacity data in demand planning. In defining these data, similar tools as identified under sourcing are required. Furthermore, it was argued that purchasing should also be able to assess the effects of product

[1] An example hereof is the use of earlier defined supplier profiles for specific commodities, or the definition of a dual sourcing policy, in the subsequent, actual supplier selection decision.

design, outsourcing and demand planning on sourcing policies, sourcing activities and decisions, and supply performance, which may be supported by *access* and *analysis* tools.

Data Requirements. When we take a first look at the data that should be accommodated in systems supportive to the specific initial purchasing tasks, we can identify several core entities or data sets that are (obviously) closely related to our conception of supply in Chapter 5.

Starting point thereby are the products and activities that are outsourced. Outsourcing implies a shift in responsibilities in the supply chain; responsibilities for supplying products or for carrying out activities.[3] These responsibilities are modeled through contractual relations between organizations, involving these activities and products (see Figure 7-1).[4]

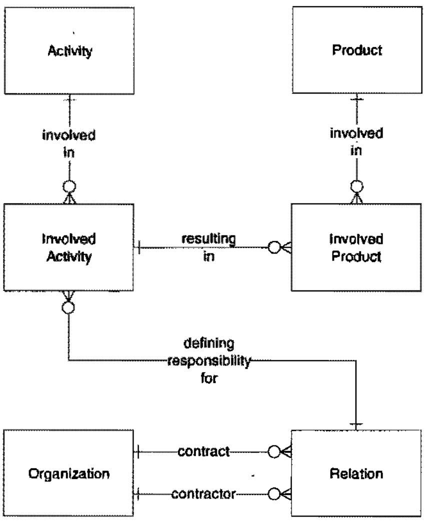

FIGURE 7-1. Basic data model for modeling simple contractual relations.

[2] Taking into account the already defined sourcing policies.

[3] As we have seen, it may be possible that the product or activity is not yet fully known at the time of entering into a contractual relation. At a later point in this chapter we come back to this issue.

[4] It should be noted that a purchase order can also be seen as a (momentary) contractual agreement and that the contracted activity therefore, a.o., includes data on the (possibly time-phased) demand covered by the contractual agreement.

In practice, the organizations agreeing upon the contractual relation may differ from those involved in the operational supply of products. The contracted activity may be split up in various sub activities that are contracted to various other subcontractors.[5] Therefore, the sensible identification of sub activities and products in the supply chain is defined by the responsibility structure.[6] It may also be the case that the organization contracting out a certain activity does this on behalf of other parties (possibly, but not necessarily, organizational entities that are part of this organization). The foregoing is depicted in Figure 7-2.

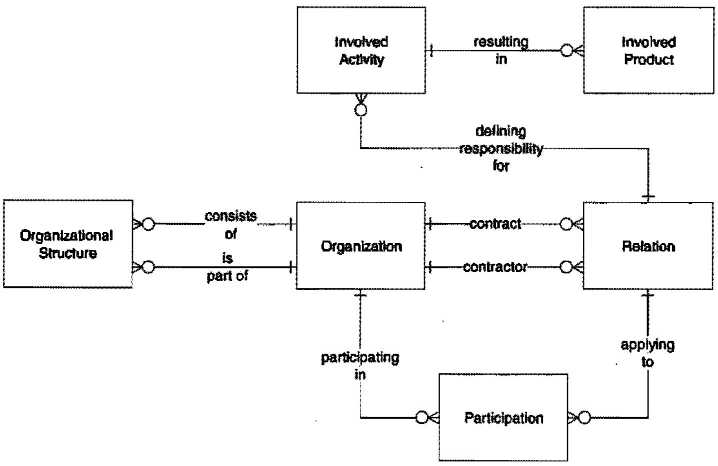

FIGURE 7-2. Basic data model for modeling complex responsibility structures and supply networks.

Next to the currently existing supply network and contractual relations, data on potential sources and their capabilities and conditions play an important role in initial purchasing. The capabilities of potential sources can be described in a similar way as the already existing contractual supply chain relations, viz., through their potential activities and products. To allow the

[5] Sometimes, these other parties are part of the main contractor but this does not necessarily have to be the case. In essence, the delegation of the responsibilities to an organizational entity that is part of the contracted organization does not even have to be different from subcontracting an external subcontractor; a formal contract may also be in place.

[6] This does not imply that more specific sub activities and their relations are not relevant, however, they are not relevant from the perspective taken here.

recording of more general conditions the potential source makes use of, a data set for the potential (contractual) relation is also required. Furthermore, in allowing other organizations (e.g., other plants or business units) to follow the sourcing activities and its results, and to allow participation and coordination of contractual relations, the earlier defined more complex relations between organizations and contractual relations are required. Summarized, the data model depicted in Figure 7-2 can also be used in modeling potential contractual relations, although the status of the data of course differs. Later in this chapter, we come back to these models in more detail.

To support activities on the level of policy-making, and subsequently to use these policies in sourcing activities, more abstract *classifications* of the already identified elements are required like (a) the grouping of activities and operations in classes such as technology types and service categories, (b) the grouping of products in product categories such as brands and commodity groups, (c) the grouping of organizations (suppliers and contractors) in organizational classes, and (d) the grouping of contractual relations in relationship classes. These classifications allow the user to define rules on a class level applicable to all the instances of the class. Later on in this chapter we come back to the use of classifications.

Existing Tools for Purchasing Support. Regarding the availability of any existing IT tools specifically addressing purchasing issues we refer to the discussions on the current state of affairs discussed in Chapters 2 and 3.

Support for Managerial Tasks in Initial Purchasing

Model Requirements. The managerial tasks performed by purchasing require support for:

1. *Defining Purchasing Procedures.* This task may be supported by tools that allow the *definition* of specific rules or reference data about the way in which purchasing tasks involved in the projects have to be carried out in specific cases (e.g., required involvement of specific organizational functions or even outside suppliers in an activity, authorization rules, attorneys, when are supplier visits required, etc.). Furthermore, the definition of working methods and detailed procedures may be supported by tools that enable the recording of project plans and procedures (for specific cases that are identified).

2. *(Multi) Project Management.* If the (multi) project management task of purchasing has to be supported, tools need to address such issues as the *definition* of the project organization and staffing thereof, definition of project activities and the allocation of staff to these activities, project planning, and project control (in particular regarding time). Furthermore, the nature of multi disciplinary teams working on these projects may be supported by tools that provide *communication* functionality in the broadest sense (e.g., tools to support document distribution and access, group meetings, informal bilateral communication, etc.). Finally, tools to support the definition and management of project *documents* are required to be able to manage the large number of documents that are used (by many people, sometimes concurrently) throughout a project.
3. *Operational Management.* This managerial task involved in initial purchasing may be supported by IT tools that allow *access* to, *propose*, or even automatically *trigger*, specific purchasing tools or applications that are used in the actual execution of initial purchasing tasks. Tools might also support the *choice* of the exact procedure to apply in the case involved (and thus also provide possibilities to record the specific case for which a particular process is carried out). Furthermore, these tools might also support the *issue* of work orders to specific resources (e.g., purchasing units, or even individual purchasers) thus forming 'to do' lists for these resources, and the *monitoring* of the status of these work orders (see, e.g., Industry Snapshot 7-1), work in process, etc.

INDUSTRY SNAPSHOT 7-1. Status Tracking at Océ-van der Grinten.

At Océ-van der Grinten — the Dutch manufacturer of copiers, printers and plotters — research and development activities are closely integrated with sourcing activities. Based upon so called quality levels in research and development, specifications of items are 'released' in a phased way. Quality levels that are used are IDE (identified — code number assigned), PRE (preliminary — specification in process), REV (reviewed — assessment of design quality), APP (approved — manufactured and tested), and FIN (final — quotation agreed, item tested, may be released (REL)). A similar concept is used in sourcing. Status levels that are used for the sourcing process are E (evaluation has been initiated), EA (remarks arised from evaluation), O (quotations have been requested), OA (comments on quotation), OG (quotations roughly agreed, details still have to be negotiated), and OD (details have been agreed).

Based upon these 'levels' a reference process was defined (see Figure 7-3) and a supportive system was put in place. In this way the status of the whole process as well as parts thereof could be monitored on an item level.

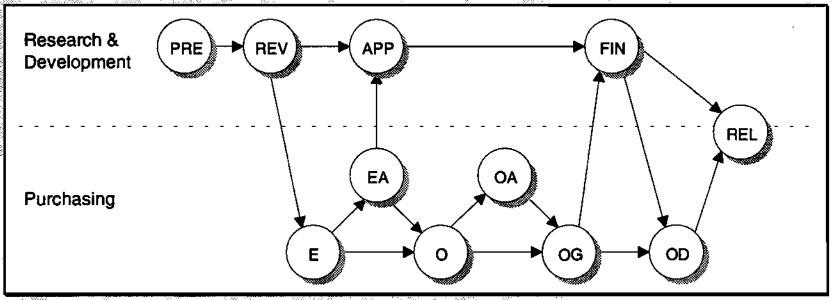

FIGURE 7-3. Status levels used in process monitoring.

Data Requirements. When we take a look at the data that should be accommodated in systems supportive to the managerial aspect of initial purchasing, we can identify several core entities (see Figure 7-4).

First, it is desirable that the way in which projects are handled (i.e., the process) can be defined through the definition of *activities*, their structure (WBS) and sequence. The precedence relations are thereby defined through the definition of input and output *documents* (and their structure) such as specifications, approved or preferred supplier lists, evaluation spreadsheets, etc.). To actually carry out the activities, *resources* (e.g., organizational units, teams and/or persons) need to be made responsible and allocated to the activities.

On a lower level of detail it should be possible to define the actual *operations* that make up the activity. These operations are normally carried out by specific people ('operators') using *tools* such as word processors, spreadsheets and other more specific applications such as ERP systems. At this level of detail it is, however, not relevant to define the specific relations between the operations itself.

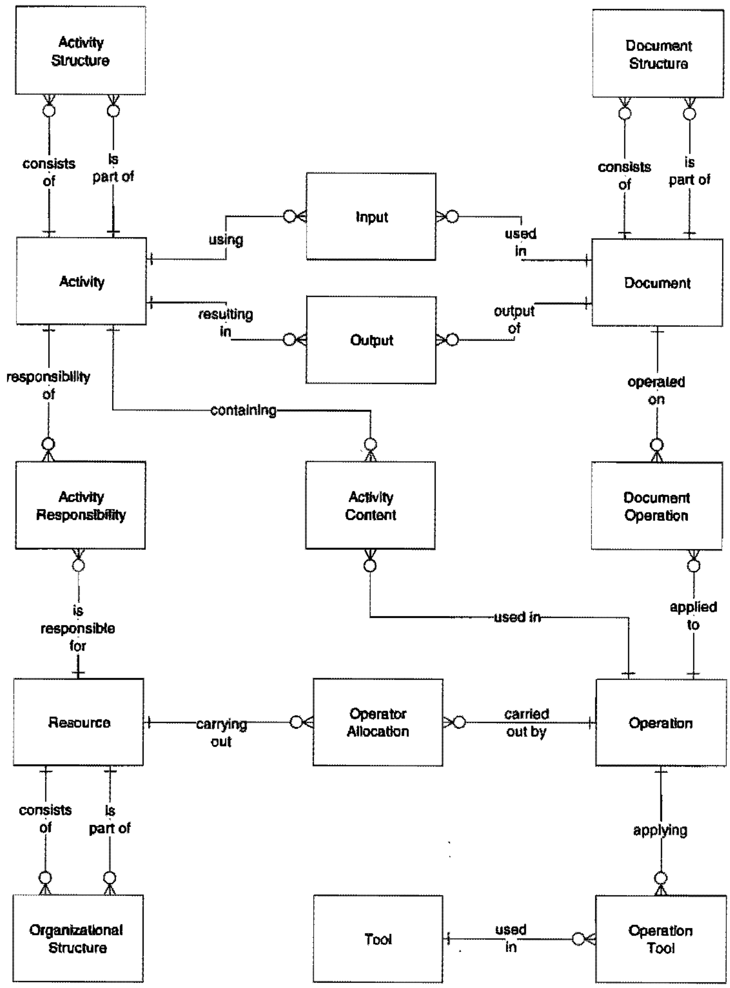

FIGURE 7-4. Basic data model required for managerial support.

Similar as for policy-making issues in sourcing, for the task of defining procedures for specific types of cases, it is useful to define *classifications* such as activity classes (like project classes), resource classes, etc. This allows the user to define class specific procedures (including reference activity structures, reference project teams, etc.). Later on in this chapter we come back to the use of classifications in more detail.

Existing Tools for Managerial Support. When looking at the managerial purchasing tasks, tools that appear on the scene are project management packages, groupware, document management systems, and workflow management systems. Without going into too much detail, these tools are discussed below.

- *Project Management Systems.* Project management tools generally provide functionality for project planning, scheduling and control. Functionality is available to record the hierarchical Work Breakdown Structure or WBS of the project involving the definition of project activities and sub activities and their mutual relationships, and the Organizational Breakdown Structure (OBS), involving the definition of organizational units for specific project activities. Furthermore, these tools allow the definition of a network plan of the project activities (i.e., precedence relations, including duration, beginning and end dates, etc., and capacity requirements and rates) and the subsequent scheduling of these activities (including capacity leveling). Project control in these packages mostly involves the possibility to report on actual versus planned duration, capacity usage, and costs. More than 150 project management packages are available in the market place. For an overview of these packages we refer to the web site of the Project Management Institute (PMI) (http://www.pmi.org/pmi/mem_prod/prod_ser.htm). Examples of project management packages are Microsoft Project, Primavera Project Planner, Project Scheduler, Promis, and Time Line.
- *Groupware.* Groupware can generally very broadly be defined as systems that support the communication between people or groups of people in their pursuit of a common goal or task. A well known taxonomy of groupware applications is provided by Ellis, *et al.* (1991, pp. 38-58) (see Table 7-1). A very interesting example of inter-organizational groupware was already described earlier (Chapter 2), when discussing a prototype system used by a car manufacturer and its suppliers, consisting of video conferencing software, a shared whiteboard application, and a product library accessible through the World Wide Web (Southey and Smith, 1995). Many public agencies in the US also use the WWW for communicating purchasing procedures.

TABLE 7-1. Taxonomy of Groupware and Some Examples

		Time	
		Synchronous	*Asynchronous*
Place	*Local*	Group Decision Support Systems (GDSS)	Bulletin Board, World Wide Web (WWW), Intranet
	Distributed	Videoconferencing	E-mail, distributed document access (e.g., Lotus Notes)

Source: adapted from Ellis, *et. al.*, 1991, pp. 38-58.

- *Document Management Systems.* Document management systems generally address the management of documents, and of data about these documents. The content of these documents, however, is considered a black box from the viewpoint of the document management system. Based upon Breuls (1996), document management systems contain functionality for (a) storage, preservation, and (distributed) retrieval of documents (Repository Management), (b) identification, version and status control, structure maintenance, authorization (Structure Control), and (c) life cycle management including the definition, planning, registration, monitoring and support of workflows (Workflow Management).
- *Workflow Management Systems.* Workflow management systems are fairly recent IT tools that generally support the definition (including any interfaces with the required applications for the actual execution of the work) and control of administrative workflows. Workflows can be interpreted as concrete and specific instances of processes for handling concrete and specific jobs or work orders, mainly involving data processing. Characteristics of these workflows are that they mostly are known beforehand, and that they are well structured. Next to this core functionality, workflow management systems sometimes also address issues such as planning, simulation, document management, and organization and capacity modeling (see, e.g., De Heer, 1994). Meanwhile, many workflow management systems have become available (for an overview we refer to De Heer, 1994 and Workflow Magazine, 1995). Examples of workflow management systems are ECHO, FlowMark, FlowPath, OPEN/Workflow, Plexus FloWare, Process IT, Staffware,

TeamFlow, and WorkParty. An example of a software package that makes use of some of the workflow concepts specifically for the operational purchasing process (from requisitioning, through ordering, receiving, invoice handling, to payment authorization) is SMART*Stream* PROCUREMENT.[7]

It may be clear that in the field of purchasing management there are many generic tools available in the market place. From the brief descriptions of these tools, however, it may also be clear that there is some overlap in the functionality these tools provide, and that the functionality provided by the various tools do not exactly map onto the purchasing tasks that were identified. Furthermore, the actual application of these tools requires an extensive analysis of the purchasing processes that take place. This last remark does not only pose a requirement on the purchasing function before these tools can be implemented in the purchasing environment, it also provides the opportunity to re-engineer these processes before such tools are actually implemented.

DESIGN PRINCIPLE 2 — SUPPORT FOR EXTENSIVENESS

There are several developments that contribute to the need for more extensive data models, capable of more realistically modeling individual suppliers as well as the whole (or at least a part of the) supply chain. These developments are longer and closer business relations, early involved suppliers, and the move towards buying services instead of concrete products.

The Network Partner. Throughout this study, it has become very clear that present day companies to a large extent depend on the performance of their suppliers, and of course on their products and services. Furthermore, companies are moving towards longer and closer relationships with less and less suppliers (or therefore sometimes indicated as 'network partners' (Van Weele and Rozemeijer, 1996, p. 19, 52)).

As such business relations move from transactional to almost institutionalized, it may be clear that the choice and implementation of the right relationship deserves considerable attention. This attention expresses

[7] This software package, however, also integrates specific functionality required for specific purchasing tasks.

itself, for instance, in extensive and considered evaluation schemes for use in initial purchasing. If these schemes and corresponding working methods have to be supported and thus accommodated in a supportive system, extensive data bases are required. Supplier selection, for instance, cannot be based upon only the supplier's price and former performance, but instead will be based upon an assessment of its competencies, manufacturing equipment, cost structures, control systems, commercial relations (e.g., the supplier's suppliers and customer references), financial status, technology road map, investment plans, personnel distribution and educational levels, and so on.

As current systems generally only accommodate a simple, limited, and rigid data set to describe a supplier, these systems are not at all suited to support the sourcing decisions in initial purchasing. More extensive data models are required, enabling the extensive modeling of individual suppliers as well as the whole supply chain.

The Early Involved Supplier. Another development requiring extensive data models representative of supply as well as of individual suppliers, is the move towards the early involvement of suppliers. When suppliers are invited early in product development process, there are no detailed product specifications available when sourcing decisions are made. Therefore, sourcing decisions are increasingly based upon supplier capabilities that are thought relevant for future performance.

Again, systems to support sourcing decisions in such an environment need to accommodate more than the typical systems of today are capable of.

The Move Towards Buying Services. In Chapter 5 of this study we distinguished between the buying of products and the contracting out of services (or activities). From the foregoing, it may be clear that concrete products play an increasingly less important role in sourcing decisions. Products still have to be developed (partly) and therefore, sourcing decisions more and more are based upon an analysis of the capabilities of the potential supplier. As suppliers are more and more responsible for (part of) the product design, a large part of what is actually being bought when buying a product from a supplier, is the design of the supplier. Of course, the quality of this design is to a large extent influenced by the design and engineering capabilities of the supplier. Furthermore, services in itself are more and more subject to outsourcing.

Because of the above, companies are more and more contracting out activities instead of actually buying products. Again this leads to the need for more extensive data models capable of representing the potential supplier's capabilities, including its supply network.

Data Requirements. Starting point in detailing the data requirements is the basic data model provided in Figure 7-2. When looking at the way in which sourcing activities can be supported, the extensiveness principle calls for a detailed model of potential sources. This requires the possibility of modeling their organizational structure (for instance, to be able to identify the parent company), the way in which responsibilities are dealt with (for instance, to identify where the responsibility for product design resides, and who the supplier's component suppliers are), as well as their processes, products, operations, and tools and production equipment used. It may even be required to trace the supplier of critical production equipment. Furthermore, in the evaluation of a source, references to other customers of the potential source may be relevant. The inclusion of contractual relations with suppliers also allows for the definition of customers of the potential source. The same data structure can then be used for data on the potential source's relation with the reference customer. The foregoing has been depicted in Figure 7-5 on the next page.

DESIGN PRINCIPLE 3 — SUPPORT FOR FAMILIARITY

Making Use of Reference Data

State Dependent and State Independent Data. In their architecture, software packages mostly make a distinction between relatively static data, primarily used for reference purposes, and more dynamic and transitory data (see also Porter's reference model in Chapter 3). In MRP II or ERP software packages this is sometimes referred to as a distinction between state independent and state dependent data (Bertrand, *et al.*, 1990, pp. 117-119). Adapted to the administrative environment of purchasing, 'state' thereby refers to the state of specific cases in the purchasing process. State dependent data therefore concern the definition of specific cases and documents (including their state in the actual process), project teams, capacity allocation and usage, etc. State independent, or reference data concern data that exist independently of any specific case that needs to handled by purchasing like sourcing policies and purchasing procedures.

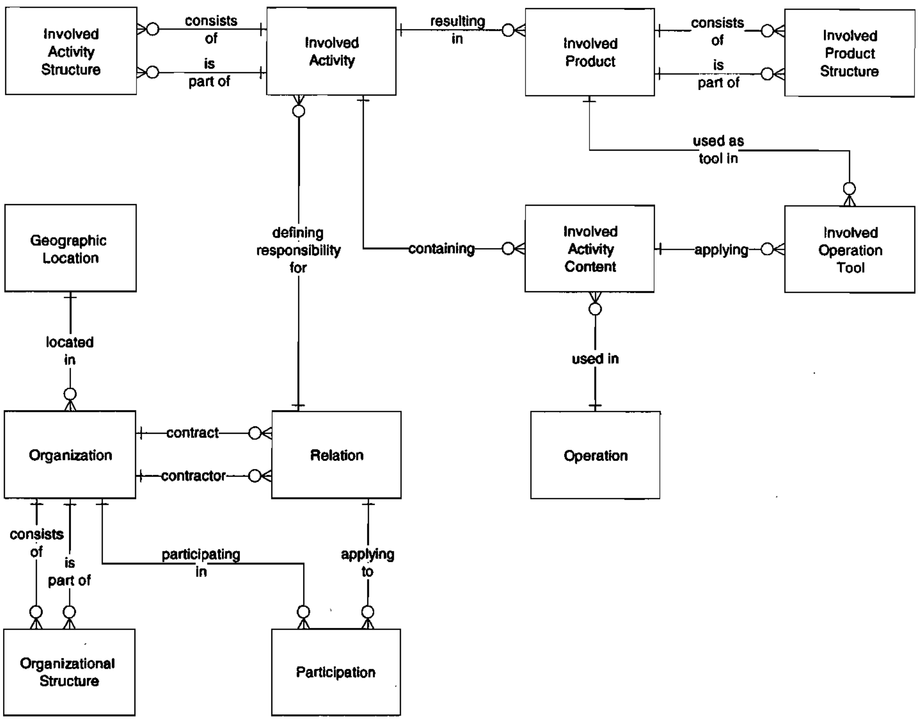

FIGURE 7-5. Detailed data model for modeling potential sources.

The earlier discussed customer order decoupling point or CODP, and the fact that we are focused on providing support for new task situations give rise to discuss the effect of the difference between case specific and anonymous purchasing activities on the supportive information system. This is done analogous to the discussion on the consequences of a shift from a make-to-stock environment towards customer driven manufacturing for MRP II packages, as discussed by Bertrand, *et al.* (1990, pp. 144-161).

Exploiting Existing Knowledge through Reference Data. Most of the currently available systems support processes that are only partly case specific (e.g., systems suited to handle a purchase requisition in a repeat buy situation). A large part of the data that is required to handle the case is already available in these systems. Example hereof are data on item specifications, preferred suppliers, lead times, contract conditions, prices, etc. In handling such a requisition, use is made of these reference data.

Furthermore, the approach required to handle such a purchase requisition is well-known.

This example shows, that systems supportive to purchasing can be used to accommodate concrete reference data on both the case to be handled and the approach to take (which we will refer to as managerial reference data). Managerial reference data may include both data on purchasing policies or procedures (e.g., reference project plans, work breakdown structures, workflows, and project staffing) and sourcing policies (e.g., supplier profiles, checklists, etc.).

In most cases that we consider, however, it is precisely the task of purchasing to define the data for use in (repeat) ordering. But although much of the purchasing data are not yet known in those cases, the approach to handle the type of case of course might be known. For instance, when product specifications are not yet known, and when we have no clue yet of a potential supplier, and where to find such a supplier, it still might be possible that we know the way in which we are going to deal with the case. In such a case, a system could provide support by providing managerial reference data descriptive of the approach required to handle the case (i.e., either purchasing and/or sourcing policies). However, when even the general approach to deal with a specific case is unknown, it is even impossible to provide such managerial reference data. A system can then not be used to provide any reference data and can be characterized as an 'empty' system (which, however, does not imply that no support can be provided). When a case is partly known (e.g., a list of qualified suppliers is available and the approach that is required to handle the case is known) a system can help in providing a buyer with the already available purchasing data on the case as well as with information on how to handle the case.

The above brings us to the conclusion that we can identify the possible level of support that can be provided by (state independent) reference data through an assessment of the familiarity with the content of the case and the approach to deal with the case (see Figure 7-6).

Most of the currently used systems in purchasing are focused on accommodating only reference purchasing data. This is remarkable, because these systems generally are used in simple, repeat buy situations in which cases are handled in an often standard, well known and well structured procedure. The characteristics of this type of situation also indicate opportunities for the application software to provide functionality to support the definition and execution of the procedure to handle the cases. A first step to take therefore might be to bring in functionality to support the managerial tasks of purchasing in repeat buy situations.

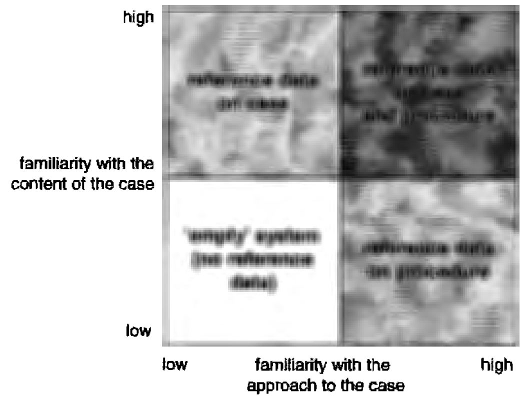

FIGURE 7-6. Using the familiarity of a case to determine the possible level of support by reference data.

Data Requirements. To allow users to make use of already existing data on *cases*, it is necessary to include possibilities for classifications. For instance, based upon a specific source class (e.g., carriers), users should be able to identify already existing instances of that class (i.e., actual carriers). Usually, these classes are implemented by classifying features of the object which allows multiple, but rigid and single level classifications.

To allow users to make use of data on *sourcing policies* to be used in a specific case, a more extensive structure is required. After identifying an object class, the user should be able to define policies on various features related to the object class. For instance, through the identification of the source class, the user may identify the 'normal' criteria and norms that are used in evaluating such a source. The object class in itself now requires possibilities for registration, implying an entity in the data structure. This structure can of course also be applied to the other data sets in Figure 7-5.

The same holds for the purchasing procedures that, e.g., might apply to a specific class of purchase cases. These procedures may, e.g., include reference data on the 'normal' activities and organizational functions involved in handling the case. This implies that the related data sets used for recording state dependent, i.e., actual data should also be available in the state independent or reference part of the system, only then applying to classes of these instances. This 'copy' has the status of a directive or reference model for actual sourcing activities. When needed, the reference data can be copied to the state dependent part of the system and used in an actual case. Part of the data model belonging to this approach is depicted in Figure 7-7 (based upon Figure 7-4).

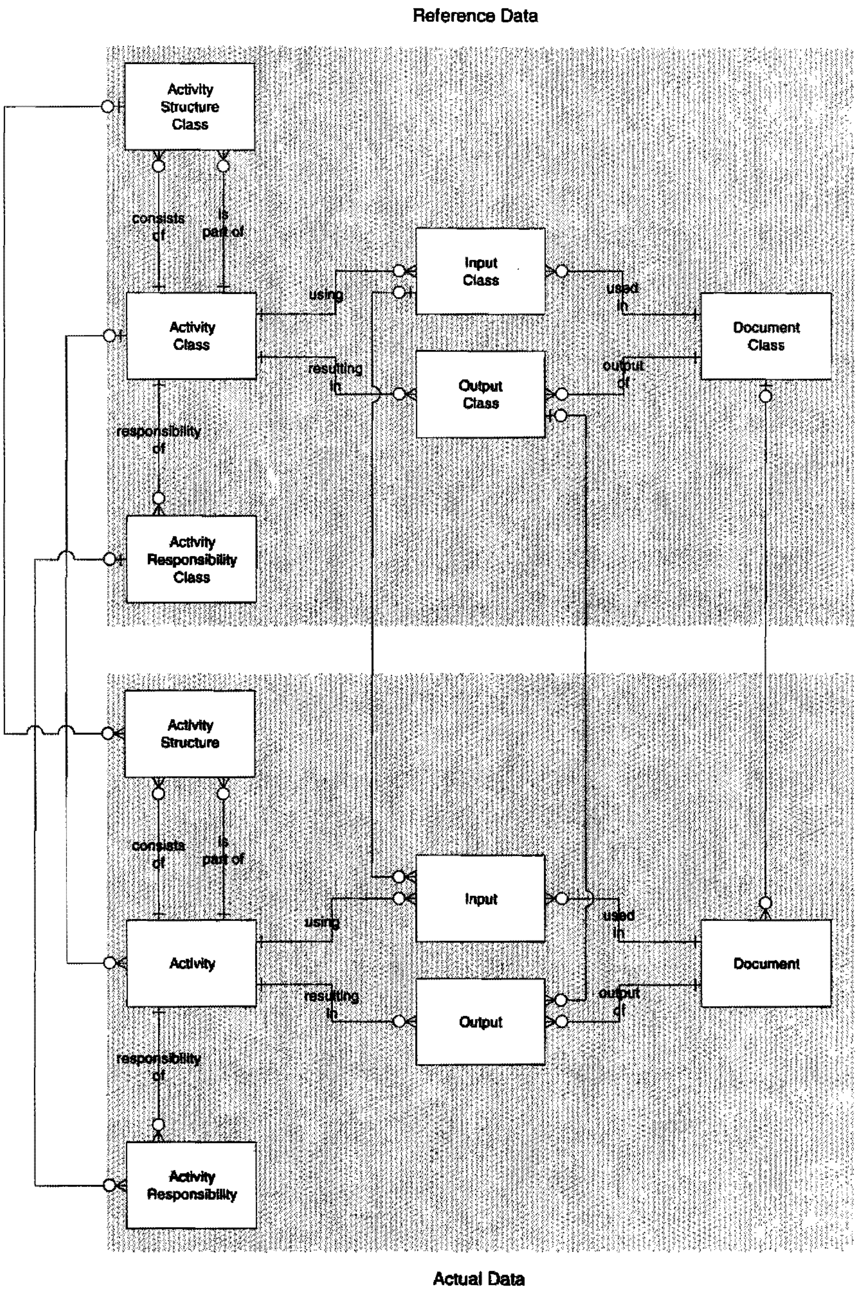

FIGURE 7-7. An example of a part of the data model allowing the definition of purchasing procedures on class level.

DESIGN PRINCIPLE 4 — SUPPORT FOR DIVERSITY

Diversity in Purchasing

Initial Purchasing Diversity. During the case studies it became apparent that there are many different cases that need to be handled by purchasing. These differences thereby resulted in many different ways in which specific purchasing issues were dealt with, e.g., different evaluation methods for selecting different type of suppliers, different contract conditions, etc. (see, for instance, Industry Snapshot 7-2).

INDUSTRY SNAPSHOT 7-2. Market Research Checklists at Philips Medical Systems Nederland.

In their market research activities, buyers at Philips Medical Systems Nederland (PMSN) can make use of checklists. Several checklists for different types of goods and services were therefore designed. Based upon the type of goods or services — identified by a so called CLOGS code (Classification of Goods and Services) — a checklist could be selected from PMSN's 'Quality Handbook Purchasing' which could then used in actually carrying out the market research activities. These checklists all contained different, but sometimes partly overlapping, characteristics to assess during market research and qualification activities.

These differences pose some problems for possible supportive systems. If, for instance, different classes of suppliers (e.g., suppliers, contractors, or service providers) need to be accommodated in an information system, this leads to the incorporation of different data sets in the system. If only a few different types need to be accommodated, this is not a problem. If, however, there are many different types that need to be accommodated, this may lead to very complex systems that are not maintainable. Therefore, although we have argued that the familiarity of cases might indicate a possibility for recording reference purchasing data, a large diversity of cases will easily result in complex information systems using the data models used until now.

Purchasing Management Diversity. The differences present in case characteristics also resulted in many different 'managerial' ways of handling the different cases. This results, e.g., in different process durations, different cases handled by individuals or by project teams, differing responsibilities, etc. Again, if only a few procedures, for instance, are recognized, this may pose no problem in recording these procedures as managerial reference data. However, if many of these different procedures or methods of approach are recognized in a particular situation, this again may result in too complex systems from a maintenance point of view.

Generic Object Modeling — The Key to Diversity

Generic Object Modeling. To give in to the potential problem of too many classes that need to be accommodated in the system, the object classes that are involved need to be modeled and implemented at a higher, more generic level of abstraction. This implies that the specific object classes have to *generalized* into a generalized (generic) objects. This generalization (referred to as *generic modeling*) allows abstractions in terms of data structures.

Object orientation provides a possibility for generic modeling. Classes describing groups of objects are the basic building blocks in object oriented modeling. For instance, the class of service providers may contain more specific logistics service providers. The class of logistics providers in itself may even contain more specific classes of service providers, e.g., value added logistics service providers. Specifying more and more specific classes (referred to as sub classes or specialties) of a more general object class (referred to as a super class) is called *specialization*. In this way recursive super class/sub class relations can be modeled. Furthermore, as super classes are generalizations of sub classes, sub classes at least have a similar specification as its super class. This implies that features of the super class are always present at sub class level. In object oriented modeling this is referred to as *inheritance*. For further reading we refer to recommendable publications by Coad and Yourdon (1991), Yourdon (1994), and Martin and Odell (1994).

Application to Purchasing. As both purchasing and purchasing management may be subject to many varied practices, the core entities in the data structures depicted in Figure 7-4 (i.e., Activity, Document, Resource, Operation and Tool) and Figure 7-5 (i.e., Organization, Relation, Activity, Product, Operation and Tool) should be generically modeled.

An illustrative example can be provided by looking at the many different suppliers or sources a company can make use of. In addition to the number of sources that are of course all different, even the classes of sources, in which all of these sources are usually categorized, are many and display many differences. However, at the top level of such a generalization/specialization hierarchy, all sources are of course organizations. In this way, one can imagine a generic organization consisting of sub classes or specialties, and ultimately the specific variants of the generic organization (i.e., concrete supplier organizations) (see Figure 7-8).

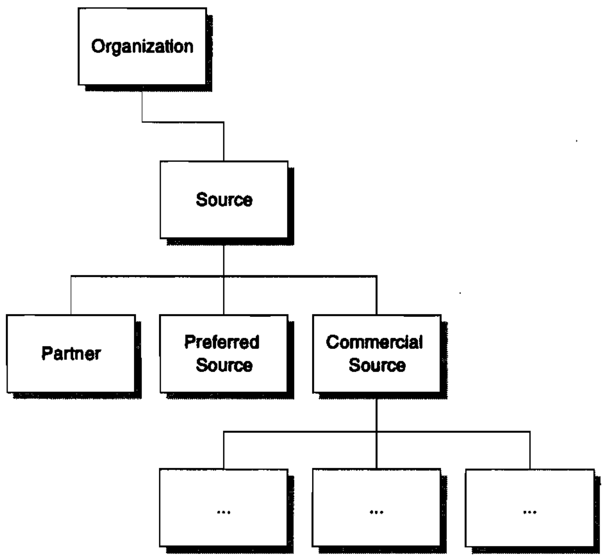

FIGURE 7-8. A possible example of a source generalization/specialization hierarchy.

The differences between source classes on the various levels of the generalization/specialization hierarchy appear from differences in their descriptive characteristics or features. For instance, the data required on a partner may differ from the type of data required on a preferred source and commercial source. Furthermore, specific sources are identified by assigning values to all of the features of the class the source belongs to. The possible values a feature can take are referred to as options. It should be noted that differences in sources can also be present because of differences in the values assigned to features of a class. So it is also possible to speak of a generalization/specialization within a class.

The combination of generic object modeling, object and class generalization/specialization, and the use of features and options allows the user to flexibly define all source classes and specific sources that are identified in the organization (see Figure 7-9).

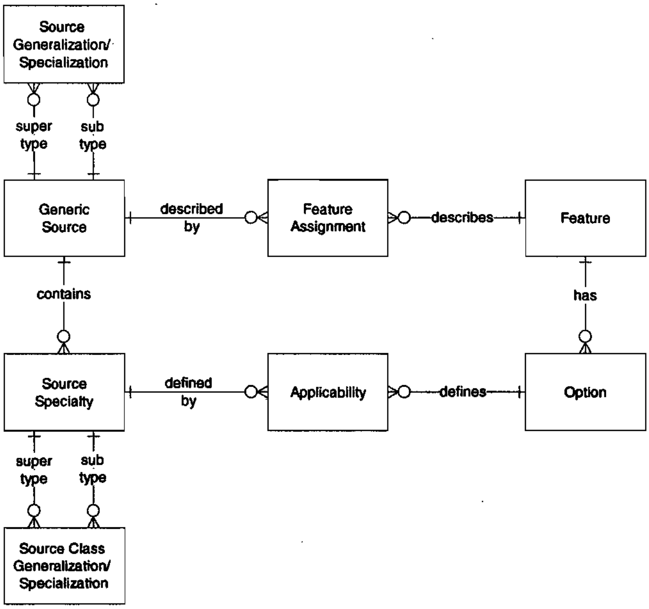

FIGURE 7-9. Data model allowing the generic definition of objects (sources, activities, products, etc.). *Source*: adapted from Hegge, 1995, p. 77.

Using the Generic Object Model — Configurator and Generator

Configuring and Generating Product Documentation. The problems posed by the (sometimes large) diversity in purchasing cases and procedures are comparable to the problems faced in production when producing a large diversity of (mostly customer order specific) finished products. Hegge (1995) provides us with a detailed and comprehensive description of these issues and — comparably to the discussion above — proposed the so called generic bill-of-material (the GBOM) as the key to the problems posed by diversity.

Next to the possibilities the GBOM provides in modeling diversity, Hegge also describes the use of the GBOM in configuring and generating a feasible product specification that meets customer requirements. A *configurator* thereby supports the choice of specialties at various levels in the GBOM until a valid variant has been identified. Then, when a specific variant has been identified by the configurator, this identification can be used by the *generator* not only for generating a specific BOM, but also for other types of product documentation (Hegge, 1995, p. 119).

Configuring and Generating Policies and Procedures. In a similar way, the generic object model can be used for the identification of a suitable sourcing policy and purchasing procedure. Based upon the case to be handled (defined by customer requirements like product/service requirements, possible source requirements and preferences concerning contractual conditions, etc.), specific policies and procedures related to that type of case may be generated (e.g., checklists for audits, selection procedures, standard contract clauses, etc.) (see Figure 7-10).

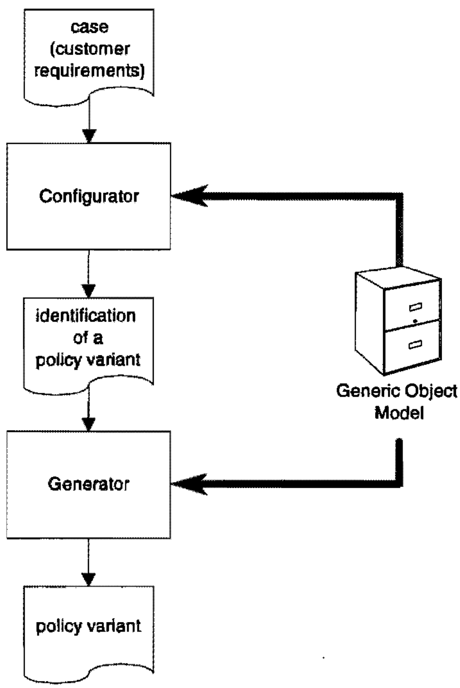

FIGURE 7-10. Configuration and policy generation process. *Source*: adapted from Hegge, 1995, p. 120.

To facilitate the use of features, the user can be supported by providing a list of possible feature values (the options) that may be used in 'scoring' the feature in specific cases (e.g., scoring a supplier on a checklist) or in defining sourcing policies (by providing possible normative values for features).

It is clear that the concept of generic modeling and configuring and generating documentation based upon case characteristics is a very powerful concept to deal with the diversity encountered in purchasing.

DESIGN PRINCIPLE 5 — SUPPORT FOR VARIABILITY

Purchasing by Wire — Flexibility and Responsiveness

Uncertainties (or Moving Targets) in Purchasing. The diversity of cases that needs to be dealt with in purchasing is only one source of complexity. In addition, purchasing also has to cope with the many (initial) uncertainties that can exist at the outset of a specific purchasing task. Product specifications, supplier profiles, suppliers, contract conditions, etc. only become known during the process itself. It is, for instance, not uncommon that specific characteristics of a supplier only become known when visiting a supplier (see Industry Snapshot 7-3).

INDUSTRY SNAPSHOT 7-3. Supplier Visits at Philips Medical Systems.

When visiting a plant of a potential supplier, PMSN's supplier selection teams often use a checklist that has been selected from their handbook or specifically designed for the case involved. Such a checklist contains criteria that are considered relevant for qualifying the type of supplier that is going to be visited. However, as suppliers are often — by definition almost — more knowledgeable of their own competencies and products and how to describe these, they often — in their answering of PMSN's questions — come up with new aspects. If considered relevant they are incorporated in the checklist and mostly also used in similar future cases.

Similarly, the approach to deal with a particular case sometimes also only becomes known during the process. Only when a particular activity has been concluded it is exactly known what should be done next. In this way, purchasing has to perform its tasks while their targets are moving.

The tools required to support the above resemble the 'fly by wire' tools used in aviation. These tools are used to augment a pilot's ability to assimilate and react to rapidly changing environmental information. Haeckel and Nolan (1993, pp. 122-132) use this analogy to introduce the concept of 'managing by wire'. Main characteristics of systems that support the idea of 'managing by wire' are *flexibility* and *responsiveness*. Tools that rigidly automates processes (like the automatic pilot) are only useful in calm, stable conditions.

If we apply this concept in purchasing (i.e., we are moving towards 'purchasing by wire') this poses some problems from a system's point of view. If relevant supplier characteristics, for instance, only become known during the process and need to be accommodated in a system, this requires some flexibility (i.e., adaptability) in the data base part of the system. Haeckel and Nolan define this process, by which information models change, 'institutional learning' (see Industry Snapshot 7-4).

INDUSTRY SNAPSHOT 7-4. The Institutional Learning Loop at Wal-Mart and Wrangler.

Every evening, Wal-Mart transmits five million characters of data about the day's sales to Wrangler, a supplier of blue jeans. The two companies share both the data and the model that interprets the meaning of the data. They also share software applications that act on that interpretation to send specific quantities of specific sizes and colors of jeans to specific stores from specific warehouses. The result is a learning loop that lowers logistics and inventory costs and leads to fewer stock outs. And every time the data model is changed to reflect a new fashion season or pricing pattern, both Wal-Mart and Wrangler learn and adapt.

Source: Haeckel and Nolan, 1993, pp. 122-132.

Furthermore, as changes in the system would need to be made by buyers and purchasing managers (not by IT specialists), making adaptations to the system should be a very simple and easy task. In that way, purchasing professionals can move into the 'information cockpit' (as Haeckel and Nolan call it) and gain the ability to modify directly how their system drives their activities.

Generic Object Models Revisited. When we reconsider the concept of the generic object model presented before, we can recognize that the identification and specification of the objects represented in this way are uncoupled. This provided Hegge with the possibility to distinguish between the product configurator and the BOM generator, but it also enables us to change the specification of an object fairly easy. As the features belonging to a specific source class, for instance, are recorded in other data sets than the identification of the source class, a possible change of such a source 'profile' through time (or even within one case specific process as we have indicated) can fairly easy be implemented through the insertion of a new feature, and assigning this characteristic to the source class. This would not even require a change to the data structure. Because of the foregoing we again suggest the use of the generic object model in initial purchasing, although now from a 'purchasing by wire' point of view.

ARCHITECTURAL CONSEQUENCES

We have now discussed several types of functionalities or applications that may be useful in supporting initial purchasing. However, just taking available software packages or developing IT tools and implementing them in the purchasing environment will not yield the required effectiveness as these systems will not be integrated. Purchasing will then be supported by many tools that will be perceived as the notorious 'islands of automation'.

Architectures

The concept of an information architecture has been proposed to serve as the basis for integration of these otherwise 'islands of automation'. Such an information architecture can be interpreted as a blueprint of the information provision in a specific domain, in this case purchasing. This blueprint, a.o., contains a demarcation of the information systems, i.e., *applications* through which purchasing can be provided with information, and a list of the most important *data sets* required to provide the necessary information (Theeuwes, 1990, p. 19; Bemelmans, 1991, p. 101). As the most important data collections have already been discussed earlier in this chapter, we now focus on the applications that should be distinguished and their interfaces.

Functional Applications. The decomposition of required purchasing functionality into several applications must take place in a very orderly and systematic way to guarantee the required integration of these sub systems afterwards. In order to arrive at such a suitable demarcation of IT applications in purchasing it is necessary to investigate the degree and nature of *cohesion* between the perceived applications. This cohesion, sometimes also referred to as the required coordination between the various applications, usually reveals itself in the interaction, communication patterns or (information) relations between the applications. The applications then have to be defined in a way that the data exchange between the applications is minimal (sometimes referred to as 'low coupling' (Page-Jones, 1988, p. 59)).

Based upon a discussion on coupling and cohesion between applications, Yourdon (1982, p. 21) as well as Page-Jones (1988, p. 84, 101) state that a 'good' architecture is based on *functional* cohesion. Such functional cohesive purchasing applications can be characterized by their clear-cut focus on a single, specific purpose and job, resulting in a specific, clearly identifiable output. It can be described by defining *what* it does by using only a single verb and a single object.

An Application Architecture for Purchasing

Managerial and Sourcing Toolkits. Reconsidering our earlier discussions on the differences between general managerial support for purchasing and specific tools for use in initial purchasing (and particularly for sourcing), we already indicated the differences in the type of data that should be accommodated in these two different types of systems. Therefore, a first distinction can be made between applications (forming a toolkit) for use in purchasing management, and those for use in sourcing.

The toolkit for use in purchasing management thereby accommodates tools for multi-project management, single project management, and — on the most detailed level — for workflow management. These tools also include functionality for defining organizational structures, project teams, personnel, and for identifying sourcing tools required in particular activities. It should be noted that these tools should also be able to interface with systems that are used for the projects as a whole (which might not be specific purchasing projects). As purchasing tasks are almost always part of a cross-functional process, especially at this level, it is clear that the IT functionality should be integrated with process support functionality in other parts of the organization.

The sourcing toolkit subsequently accommodates tools for establishing sourcing policies and for sourcing itself (i.e., for market research, supplier qualification and selection, and for contracting). These sourcing tools generally provide support for gathering data, analyzing data, and recording data (in documents). Therefore, they need to be able to interface with possible systems that can be seen as the sources of data, and those systems that can be interpreted as the destination of the data. The sources of data used in the sourcing tools, however, is less unambiguous. Sources of data can be located both internal and external to the company, and may involve systems, publications, reports, documentation, correspondence, documents, orally provided data or impressions. Furthermore, they may concern a whole range of subjects such as supplier strategies, supplier customer base, product data, performance data, quality systems, resource usage, prices, financial benchmarks, etc. Some of these data may be available in the engineering, purchasing, logistics, quality, financial or vendor rating applications used throughout the company. Most of these data, however, will not be available in internal systems; it is exactly one of the major tasks of sourcing to gather these data not internally available. With the appearance of a new technologies like the Internet, electronic catalogues and the purchasing card, the interfacing issue, however, may become extremely actual. Nonetheless, the required data preferably should be made available to the sourcing tools through the document management interface that is discussed next.

The Document Management Interface. The interface between the managerial toolkit and the sourcing toolkit is twofold. First, as we already indicated, it should be possible to plug specific sourcing tools in the managerial toolkit (which is comparable to some of the possibilities already available in Workflow Management Systems). More specific, the Tool entity type in Figure 7-4 identifies these sourcing tools. The data structure depicted in Figure 7-5 can then be seen as (a part of) data structure underlying these sourcing tools.

Second, as the most important resulting data from the sourcing tools are mostly recorded in the form of documents (e.g., a contract, a list of qualified suppliers, a policy document, etc.) that are again an important link in the processes supported by the managerial layer, the Document entity type in Figure 7-4 also forms an important interface between the two identified toolkits.

However, as document management functionality is a fairly generic type of functionality it would not be wise to subsume this functionality in either one of the identified layers, but in an intermediate, interface layer.

The Ubiquitous Communication Toolkit. Finally, in all applications there is a need to communicate (in whatever way) with other team members, other buyers, purchasing management, suppliers, etc. Therefore, communication or groupware facilities should be available independent of whatever other application layer.

Based upon the discussions so far, the application architecture for purchasing can be depicted as in Figure 7-11.

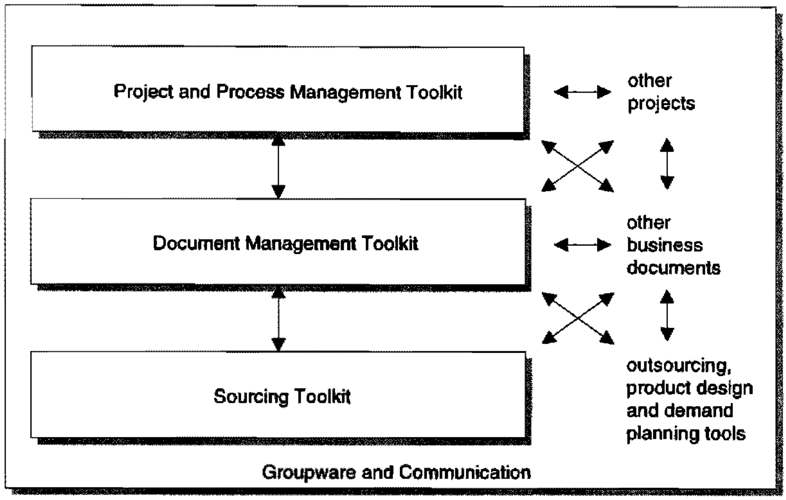

FIGURE 7-11. An initial purchasing application architecture.

SUMMARY

In this chapter we focused on the definition of design principles that can be used in the design of IT based systems supportive to initial purchasing. We also identified some generic IT tools that are already available in the market place, and described in what way they can be used to support initial purchasing. Most important conclusions from this chapter are that we need to distinguish between managerial tools, for use in purchasing management tasks, and specific support for use in sourcing. In both toolkits, use can be made of reference data to speed up the process, although this is dependent on the familiarity of the case presented to purchasing.

A document management layer was defined as the interface between these two support layers. Furthermore, we concluded that the encountered diversity and uncertainty in initial purchasing can be supported by flexible and responsive systems based upon generic object models. The chapter was concluded by presenting a high level definition of an initial purchasing application architecture.

The principles introduced in this chapter are further illustrated and evaluated in the next two chapters, where we report on the development of two prototypes for initial purchasing.

EVALUATION

—8

A Prototype for Source Selection

The fact that suppliers are jointly responsible for the results of Philips as a whole, was already recognized many years ago. Quality, for instance, has been indicated as being not just a matter of concern within Philips itself, but also of outside suppliers. Philips' Purchasing Charter of 1990 stated that "quality assurance for the products and services bought by Philips is of the greatest importance ... because of the large content of purchased material in the products sold by Philips. The delivery performance of suppliers, in every aspect, has a large impact on the performance of Philips' factories with regard to product quality, throughput time and stock levels." The Quality Improvement Purchasing Process (QIPP) project that was started as a part of the Company-Wide Quality Improvement (CWQI) program therefore also focused on the improvement of the practices within initial purchasing, and particularly in supplier selection. The Philips Quality — Supplier Partnership program of 1993 also recognized that "suppliers form an essential part of the total business chain" and that "their capability and performance strongly affect Philips' performance." It continues by saying that "the selection of suppliers is an important strategic decision" and that it is "an essential stage in the purchasing process." At the same time it was recognized that "the profound impact which purchased goods and services have on price levels, performance and marketability of Philips products demands a purchasing organization geared to make the maximum contribution to the company's profitability".

CHAPTER CONTENTS

In the previous chapter we identified five design principles that can be used to provide support to initial purchasing in industry. However, these principles are still of a more or less general nature, and are also not evaluated in a particular purchasing environment yet.

In this chapter we therefore focus on detailing some of the design principles that were described in the previous chapter. Furthermore, the practicability of the principles are evaluated in an industrial environment. This is done through the development of a prototype system supportive to source selection in an industrial company, viz. Philips Medical Systems. Before going into the details of the project, we first provide the reader with some additional background information to the project.[1]

BACKGROUND TO THE PROJECT

From the policy documents of Philips as a whole (touched upon during the introduction of this chapter) we can already conclude that initial purchasing, and in particular source selection decisions, are amongst the most important decisions within purchasing. We can also conclude that this justifies, and even requires, a purchasing organization geared to add value to Philips as a whole. This implies that purchasing should be equipped with the right resources such as capital, people, but also with supportive systems, especially systems supportive to source selection processes.

The Purchasing Information Plan at Philips Medical Systems

In the Purchasing Information Plan, which was based upon a quick scan of the purchasing processes within Philips Medical Systems Nederland (PMSN), the source selection process was briefly described. It was then stated that one of the possible projects that could be carried out based upon this Purchasing Information Plan was the systematic registration of the selection results including the motivation of the choices that were made. Another possible project was defined in the field of the automatic printing and registration of requests for quotation and received quotations, status control of quotations and the automatic interfacing of accepted quotations into the operational purchasing module.

[1] The analysis phase of this project was carried out together with Luitzen de Boer from Twente Univerisity. Marnix Werners, and Marcel de Haas provided support in actually programming the prototype. Their contributions are greatly acknowledged.

In the following years, however, most attention was paid to the setting up of a performance measurement system for both vendors as well as the purchasing department itself. Now that the vendor rating system was well in place, the time had arrived for supporting the initial purchasing decisions that were responsible for the measured performance.

Furthermore, the results of a project aimed at the support of initial purchasing could also produce valuable specifications that could be used as input for another project named 'COPICS Quo Vadis' that was running concurrently at that time. The 'COPICS Quo Vadis' project investigated the replacement of the then operational production control system COPICS by B*aa*N's Triton.

Specification of a System for Source Selection

The next step in supporting PMSN's purchasing operations with IT tools therefore consisted of providing support for initial purchasing, particularly for source selection. The project that is discussed in this chapter aimed at the delivery of detailed specifications of a system supportive to source selection. The project that was carried out before (see Chapter 5) thereby could serve as a basis for a more detailed and focused analysis of source selection decisions.

Interviews. It was already argued in the first chapter, that the functional specifications of a system can be derived from the characteristics of the decision making processes that have to be supported by the system. To get a detailed insight in these processes, use was made of an extensive interview round comprising 32 interviews with altogether 19 people from various disciplines leading to 48 hours of (taped) interviews.

Prototyping. Delivering functional specifications is one of the phases of in the system development cycle, and prototyping is one out of many ways to deliver these specifications. Prototyping can be characterized by the extensive use of working models as a means for communication between developers and end users, and its iterative nature that is supportive to the learning experiences of end users. Prototyping thus tries to improve the effectiveness of the development process.

Before we report on the results of the interviews and the resulting prototype design, we now first report on the ideas on source selection within Philips and Philips Medical Systems Nederland.

SOURCE SELECTION IN PHILIPS PERSPECTIVE

Philips' Purchasing Policy on Source Selection

In the 1993 Philips Quality — Supplier Partnership program, both selection process and assessment criteria were (pre-)defined. The selection process thereby consisted of the following four activities: (1) identify strategic products, (2) identify potential suppliers, (3) assess and select suppliers, and (4) define the relationship with selected suppliers. The prototype system only considered the identification, assessment and selection of suppliers.

Assessment criteria that were mentioned were business capability (technological, manufacturing, commercial, logistic), availability of products and services, avoidance of conflict of interest, management structure and company culture, required confidentiality, financial position, and compliance with ISO 9000 (certified by an accredited third party).

Furthermore, in evaluating a supplier, it is stated that other factors than just prices alone should be taken into account (e.g., transport, product quality, lead time, stock, etc.). This is indicated by the notion of 'total cost of ownership'.

Within Philips, a differentiated approach towards the various suppliers is advocated (the so called portfolio approach). Classifying criteria that are used in this approach are the importance of the supplier for Philips resp. of Philips for the supplier. This has led to the classification of various suppliers into to the categories of commercial, preferred or supplier partners, with an increasing investment of Philips in the relation with this supplier.

PMSN's Purchasing Handbook on Source Selection

The PMSN Purchasing Handbook describes a procedure (including some forms that can be used in this process) for source selection that serves the purpose of selecting sources (possibly from a set of preferred sources) that provide products that are expected to meet price, performance, quality and integral cost requirements.

The procedure consists of the following activities: (1) initiate the supplier selection and qualification process, (2) check possible acquaintance with the supplier, (3) identify possible other suppliers, (4) decide whether there are enough potential suppliers, (5) search supply markets, (6) decide upon further evaluation, (7) write supplier status report, (8) evaluate the importance of the supplier to PMSN, (9) classify the supplier, (10) record and archive supplier status report, (11) review and up-date supplier status report periodically, (12) evaluate possible reclassification or reconsideration.

Furthermore, numerous criteria are mentioned in the Purchasing Handbook of PMSN (e.g., a checklist for supplier evaluation, a checklist for market research, a supplier status report, supplier qualification checklists, and a Supplier Technical Information List or STIL) that for some parts are subdivided into product related categories. For supplier classification and evaluation there are also criteria (and sometimes even norms) available in the Purchasing Handbook.

PMSN's Purchasing Information Plan on Source Selection

In the Purchasing Information Plan the selection process was defined as "the assessment of suppliers and/or components based upon beforehand defined criteria in order to come to a set of preferred suppliers". Furthermore, a so called supplier choice process was defined as the criteria-based choice of a supplier from a set of preferred suppliers for the actual supply of products or services to PMSN.[2]

Data that are found out are general economic data, trade show reports, supplier names and addresses, locations, financial data, supplier capabilities and (currently available) capacity, innovativeness, composition and condition of production equipment, delivery reliability, order confirmation, product data and specifications, product lead times, prices, conditions, etc.

NEED SURVEY

As a part of the project, a rough need survey took place during the interviews. This was done to gain insight into the currently existing needs regarding source selection within PMSN. Furthermore, the results were used in setting priorities when realizing the prototype.

[2] This distinction is illustrative for the differences that were already indicated before, viz. the difference between customer order specific and anonymous purchasing activities. It indicates that PMSN strives for the pro-active and anonymous definition of a list of preferred suppliers, to speed up the case specific choice process.

Requirements on the Prototype

The response to the need survey was structured according to *logical* requirements (functional and performance requirements) and *technical* requirements (i.e., related to the hardware). First, however, we report some general figures. From the interviews we could identify over 130 suggestions, requirements, or points of attention. Most of these were related to the required functionality (75%),[3] followed by performance requirements (21%), and finally some technical requirements (4%).[4]

In order to gain additional insight in the suggestions and requirements that were put forward, an additional subdivision of both functional and performance requirements was made. Functionality requirements were further classified as:

- *Managerial Requirements.* This involved requirements in the field of process definition, justification, planning and management (progress and status tracking, project communication), and capacity management (prioritizing, planning and allocation).
- *Sourcing Requirements.* This involved requirements in the field of the phased definition of various criteria (related to various subjects during the process), the relative importance of criteria, how to score criteria, norms and standards for criteria, model assumptions, evaluation and comparison of scores, etc., and requirements in the field of the recording and availability of data.
- *Document Management Requirements.* This involved requirements in the field of report writing and (intermediate) result presentation.

When analyzing the distribution of the functionality requirements we identified that 62% of the requirements were related to sourcing, followed by managerial requirements (31%). Document management requirements scored 7% (see Figure 8-1).

[3] Which is not surprising, as in the project we focused on the identification of functional requirements.

[4] These technical requirements were mainly related to integration with other systems such as CAD systems, Triton, a Components Data Base and Library Systems. Another suggestion was a notebook for data entry at the site of the supplier (in case of supplier visits).

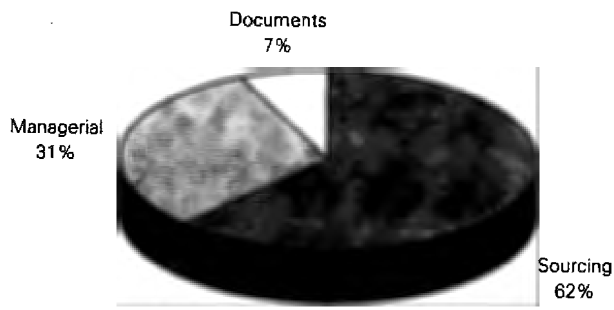

FIGURE 8-1. Distribution of functionality requirements.

Performance requirements were categorized as:

- *Flexibility Requirements.* These requirements focused on the possibilities to support various processes and decision approaches (i.e., criteria as well as weightings) in various cases, as well as supporting a change of model during a process regarding only one case.
- *User Friendliness Requirements.* These requirements involved requirements such as low data entry effort, intuitive and simple use of the system, a low threshold to use the system, etc.
- *Other Requirements.* These included requirements such as, e.g., accessibility, traceability and speed of response.

From the survey it was found that flexibility was the number one performance requirement (45%). The 31% score of 'other' performance requirements was mainly caused by the requirement on the 'accessibility' of data. User friendliness was mentioned in 24% of the suggestions.

Because of the foregoing, the project focused on providing flexible support for sourcing decision making.

SOURCE SELECTION — ANALYSIS AND REQUIREMENTS

The first, and very important part of the project consisted of a detailed analysis of different source selection cases, their corresponding processes, and the data used in those processes. The analysis was based upon the interviews that discussed 30 source selection cases (including, a.o., wiring harnesses, magnetic hard disks, fans, heavy sheet metal, mechanic subassemblies, castings, PCBs and ICs including part of the design, software programmers, and for temporary buildings). Before we summarize the main conclusions, we first describe an illustrative case in more detail.

Source Selection for Castings

The Case. Castings are relatively expensive parts that were produced based upon detailed PMSN specifications. Furthermore, castings were critical because of their long lead time (and complex manufacturing process) and because of the required investments in molds. The specifications of the castings were very detailed, but at the same time also constantly subject to changes. The supply market could be characterized by a limited number of foundries, where significant differences in price and quality were perceived.

The reason for initiating a source selection process was the perceived dependency upon the currently used foundry (also because of the investments in molds that had been done). Furthermore, the foundry's performance, particularly on delivery reliability and price level, left much to be desired. Together, this resulted in the objective of finding a second source for castings that could be added to the list of qualified suppliers.

Process and Data. After the process was initiated, the first step was primarily focused at the identification of potential foundries (a 'long list'). The primary activity in this first stage therefore consisted of consulting documentation of foundries that presented themselves, or that were visited by PMSN in an earlier stage. Furthermore, Philips' central PURCONET system was consulted for any foundries that were supplying Philips. Other sources that were investigated were buyers of other Philips plants, other companies, and specialist journals. All in all this resulted in a list of eight possible candidates together with data on their location, contact persons, sales turnover, technologies, capacity, and range of products.

The obtained information on the eight candidates was then evaluated. Aspects such as the expected ease of communication (resulting from possible language problems), the possibility to cast the required part sizes and materials, location, size, and capacity, play an important role in this evaluation. For some of these aspects norms were defined beforehand (such as location within Europe, a work force of around 200 employees, and active in several lines of business). Based upon this evaluation, three of the initial set of eight suppliers were eliminated from the list. With two foundries, problems were expected because of the language. This was considered an important aspect as the castings were expensive, PSMN specific designs with critical long lead times that required a 'first time right' manufacturing process. Communication therefore was an essential part of the future relationship with a foundry. The third foundry that was eliminated was considered too small (see Figure 8-2).

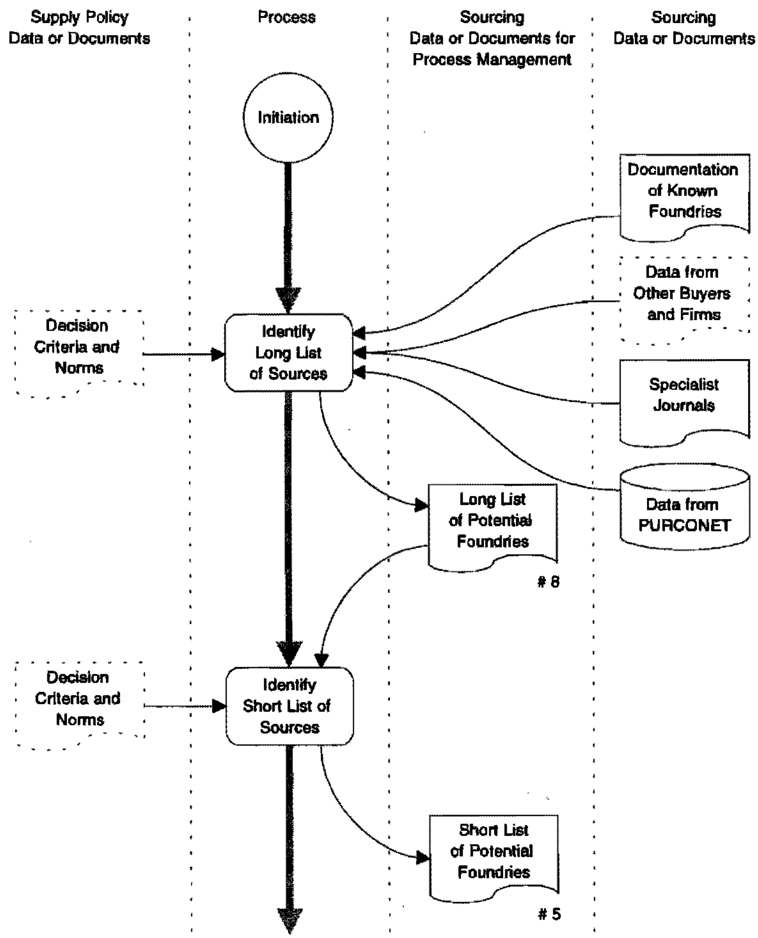

FIGURE 8-2. Stages in the source selection process for castings (part I).[5]

[5] A distinction was made between the various roles that documents play in the process. This was done according to design principle 1 from the previous chapter (viz., documents used in sourcing and documents used in process management).

Representatives of the remaining five foundries were then invited to present their companies. In these presentations attention was paid to, a.o., the foundry's strategy, policies and organization, financial status, customers, quality assurance systems, development and engineering capabilities, logistics, and delivery conditions. After evaluating the presentations, three foundries remained. The decisive criteria in this decision were the scale of operations and the manufacturing strategy (concerning the type of products that they were planning to cast in the future).

The three remaining foundries where then asked to submit a quotation based upon a sample of current castings. All three received a detailed set of drawings (including a non disclosure agreement (NDA) that had to be signed), as well as rough data on yearly demand and order quantities. Furthermore, they were required to fill out an extensive information questionnaire. In parallel, PMSN asked for financial status reports (e.g., from Dun & Bradstreet). Before the actual quotations were submitted by the three foundries, several visits were required for the clarification of the specifications and for signing the NDA. Based upon a list of over 20 explicit and weighed criteria (designed together with Development) the obtained data were then evaluated (see Figure 8-3). The foundry with the highest score was subsequently selected and got an order for the casting of several prototypes that subsequently were evaluated on their quality. This last activity — although an important part of the sourcing process — was not performed by the Purchasing department. The results thereof, however, play an important role in the final source selection decision. This last activity was depicted but is similar to the earlier figures.

The process so far (as it was not finished yet) took over one and a half years and four people from various disciplines were involved (viz., Purchasing, Development, Quality Assurance, and Service).

Discussion and Analysis

Reasons for Source Selection. One of the aspects that was analyzed during the projects was the reason for initiating the process. A first and important reason for a source selection process is an actual *customer need* for an item or service that has to be satisfied by a supplier or contractor. The reason that an external source is thought to be the most appropriate means of satisfying such a need can be manifold, e.g., it could be for reasons of lower prices, but also for reasons such as better products, increased flexibility, lacking internal know how or capabilities, or a temporary capacity-shortage to name a few.

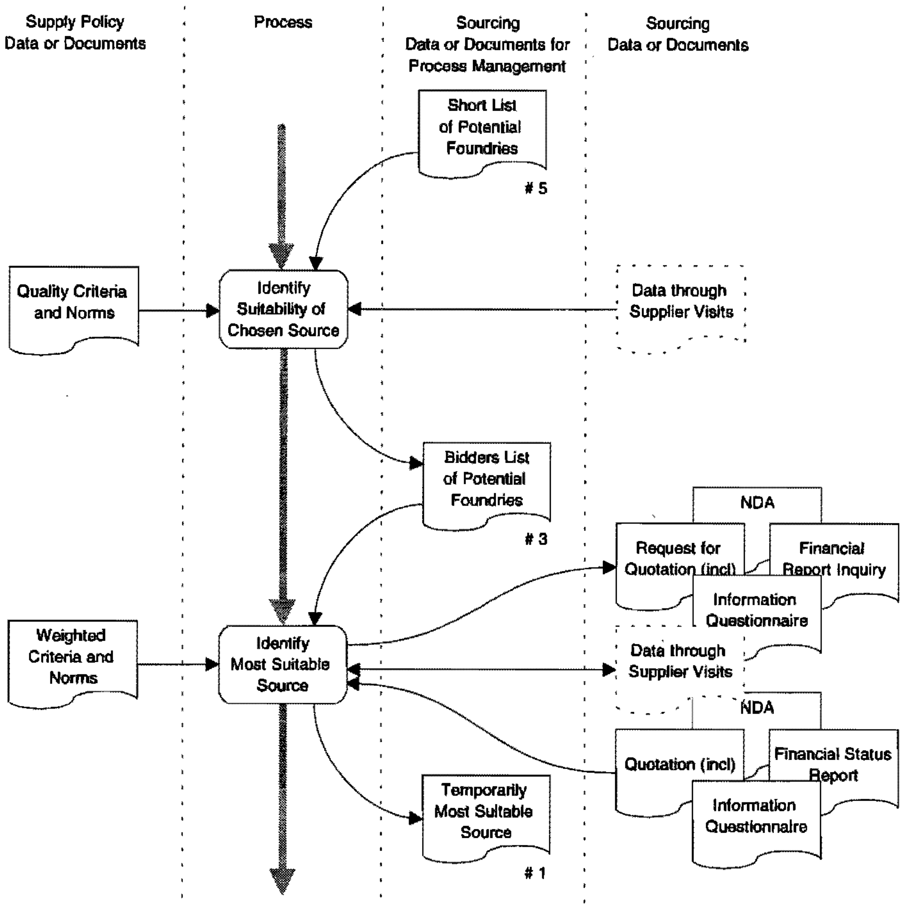

FIGURE 8-3. Stages in the source selection process for castings (part II).

If a source selection process was not carried out for such an actual customer need, still there were many reasons that could initiate a source selection process. These could be categorized as follows (we also refer to Figure 5-8 on page 125):

- *Supply Performance.* For instance, in case of positive as well as negative experiences with specific sources, vendor ratings, increasing or decreasing business, or a perceived risk (e.g., a monopolistic situation).
- *Purchasing Efficiency (Organizational Conditions).* For instance, in case the reason for maintaining a multitude of suppliers or

brands/makes cannot be demonstrated triggering a supply base reduction program.

- *New or Changed Needs.* For instance, in case of perceived new future requirements (e.g., a product development project), or changed business policies.
- *Market Developments.* For instance, in case of supply market developments such as new technologies, new products, decreasing prices, or emerging regions and nations.
- *Time.* For instance, once every two years the market is 'scanned' on the appropriateness of the existing set of qualified sources (so, periodically), when it has been a long time since the supply base was evaluated on its topicality, or when a contract expires.

Sourcing and Specifying. From the cases, the already earlier identified link between the product design (or more generally, specification) activities and sourcing was again confirmed. In many cases, specifications were at least partly defined by the source, and sources were partly identified based upon requirements specifications. Therefore, source selection processes are not as much purely focused on the source itself, but also involve activities (services) and products. When discussing source selection, we therefore also include aspects related to the activities (or services) and the products to be part of this process.

In the discussion on 'moving targets' that is yet to follow, we will come back to this issue in more detail.

Zooming Selection Cycles. Analyzing all of the 30 cases, it proved that many similarities could be identified. First, it was obvious that all cases applied a 'zooming' approach to source selection. Based upon an initially generated list of possible sources (including the product or service), the source selection process subsequently zoomed in on the finally selected source. Furthermore, it was found that each of the stages in the source selection process consisted of similar activities, viz. (1) obtaining data on possible sources, more or less based upon (sometimes explicitly defined) policies on relevant decision criteria, (2) interpreting and evaluating the available data, again possibly based upon the decision criteria (and sometimes even defined norms), and (3) eliminating unsuitable sources. This knowledge led to the conclusion that the sourcing process can be depicted as a sequence of 'zooming selection cycles' (see Figure 8-4).

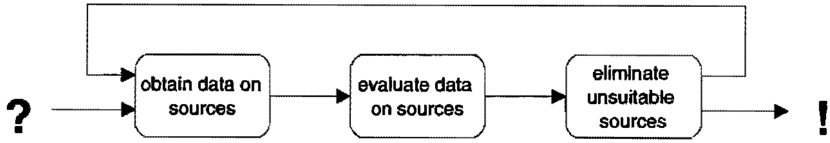

FIGURE 8-4. Zooming selection cycles in the sourcing process.

From the cases that were discussed during the interviews we could conclude that sourcing processes ranged from two selection cycles to a maximum of six cycles to finally select a suitable source.

Information Sources. From the above we can see that finding information sources and obtaining relevant data from them is one of the most important activities that is carried out during sourcing.

Information sources are located both internal and external to the company, and involve the use of systems, (electronic and hardcopy) publications (like journals, directories, etc.) and documentation (brochures, catalogs, product data sheets, etc.), both formal and informal requests for information to other employees within the company, other companies, customers of potential sources, commercial service providers (like Dun & Bradstreet),[6] and the sources themselves (including, e.g., requests for quotations), visits to and from suppliers, visits to trade fairs, and evaluating and testing prototypes.

Moving Targets. The search for and evaluation of the obtained data is guided by an evolving set of decision criteria, and possibly, corresponding weightings and norms. These criteria are interpreted as being a sourcing policy and are therefore defined as part of the sourcing policy making task of initial purchasing. In the first activity, that of collecting data on possible sources, these criteria are used to focus the attention on the right data to collect. During evaluation, the criteria govern the interpretation of the data so that unsuitable sources can be identified and subsequently eliminated from the list of possible sources.

These criteria and norms are also the key to understanding the interface between the product design (or specification) process and the sourcing

[6] This can be interpreted as outsourcing part of the source selection process itself, and can be discussed in a similar way. For sake of overview, however, we do not discuss this at this point.

process. In fact, the decision criteria and norms that are imposed upon the potential source are of a similar nature as the item or service specification. The decision criteria in fact constitute a requirements specification not so much for the product or service that has to be sourced alone, but include a requirements specification for the source as well. At Fokker Aircraft the corresponding activity and the resulting 'supplier profile' are even described in this fashion (see Industry Snapshot 8-1).

INDUSTRY SNAPSHOT 8-1. The Definition of a Supplier Requirements Specification at Fokker Aircraft.

When designing a new sourcing process for setting up relationships with early involved suppliers, Fokker Aircraft explicitly defined an activity that was named 'definition of supplier requirements'. The activity implied the determination of the development activities that were going to be carried out by the supplier (the supplier's workshare), as well as the definition of multi disciplinary requirements in the field of engineering capabilities, financial status, logistics, product support, price level, quality, and manufacturing. The activity should be concluded with an integral Supplier Requirements Specification (SRS).

There are three aspects to this important set of criteria. First, the set of governing criteria is different for different cases. On a higher abstraction level, however, an initial set of criteria is sometimes available to the sourcing process (these are the well-known checklists for certain types of items and sources that are frequently used in market research and source selection). Still, a large variety of such checklists may be present.

Second, the initial checklist, provided that such a checklist even is available, is a very dynamic set of criteria. During the selection cycles, the focus of attention in these criteria tended to shift from rough to detailed (and from source related criteria to item related criteria), and from compulsory or knockout criteria through urgent to adventitious criteria. Furthermore, during the process, criteria are constantly added, left out, and their definition altered. Therefore, although we considered the definition of these criteria and norms part of supply policy making, the subsequent adaptation of these policies (and thus the functionality to do so) should be closely related to the sourcing process itself.

Lastly, it is not unimportant to note that the source specification — like the product specification — is not the same as an actual source — or product — that suits that specification. Systems supportive to sourcing processes therefore should be able to differentiate between the registration of a source specification (the desired or required 'source profile'), and the registration of concrete and specific sources.

Implications for IT

Monitoring Capabilities. First, any system supportive to the managerial aspects of source selection should be able to support the identification of a 'customer order' (or case). Furthermore, as many reasons for initiating sourcing activities are not specifically related to a customer need, project orders are required to track anonymous sourcing activities.

These anonymous cases are initiated only after certain events have taken place. To spot these events, 'monitoring' capabilities are required to track (1) supply performance (e.g., vendor rating systems, purchasing turnover per item and source, and number of supplier per (class of) item), (2) purchasing performance and organizational conditions (e.g., the number of suppliers per buyer), (3) new or changed needs (e.g., upcoming product development projects), (4) market developments (e.g., possibilities to record any new products, brands, suppliers, etc. without a specific project or customer requirement attached yet), and (5) topicality of the supply base and contracts (e.g., possibilities to time stamp source related data to spot the topicality and reliability of these data).

Accommodating Extensive Supply and Source Models. The backbone or primary structure of the system should comprise primary data sets for recording data on specific potential sources (or generally, for organizations), and their capabilities. This means that we should be able to record data on a specifically identified organization, its specific activities (e.g., activities such as distribution, catering, supply, transport, maintenance, etc.), and (possibly) the specific items that are involved.

As many of the data on, for instance, standard items are of course the same for more than one specific organization, it is wise to record these data only once, thus preventing redundancy and the corresponding potential consistency problems. Still, however, it should be able to document subtle differences for the items specifically supplied, distributed, etc. by the identified source (see Figure 8-5, which is the same as Figure 7-1 discussed under Design Principle 1).

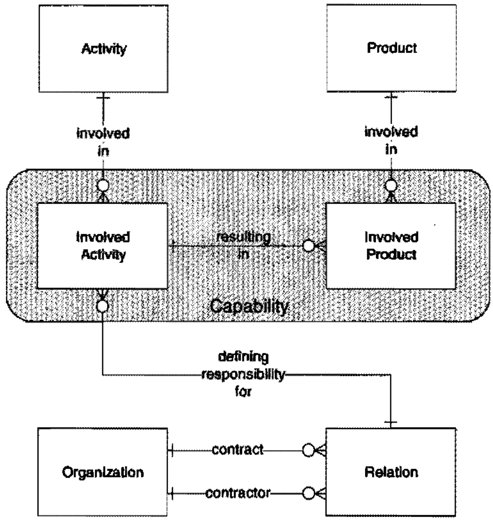

FIGURE 8-5. Basic data model of the backbone of a sourcing system.[7]

If extensive audits of a source are part of the sourcing process, then it might also be required to accommodate data on the country of the potential source, the organization's specific organizational structure and processes, and the specific tools and equipment utilized in these processes. These tools and pieces of equipment are of course also items, although they serve a different purpose in a business. From an even broader point of view, these tools, just as much as the items already discussed, are also often bought or leased by the organization under consideration. Therefore, it is wise to record tools and equipment as items, but with a relationship to the activity where they are utilized, or possibly even the items that they are used for if considered relevant.

Tools and pieces of equipment itself might be bought from other parties in the network of organizations, which brings us to the next point of attention, viz., supply networks. If supply network or supply tiers of a potential source is considered relevant in the sourcing decision, a system should be able to document this specific supply network. Examples that indicate such need are, e.g., the desire to track customer references, second tier materials suppliers, or for documenting equipment suppliers. Other

[7] Please note that until now, the discussed data are specifically recorded for a source, and that accordingly we are now discussing the state-dependent part of a supportive system. State-independent issues will be discussed later in this chapter.

examples include the possible need to identify maintenance contractors for critical equipment of an important main supplier, to identify any politically or environmentally undesirable supply chain links, or to identify third party transport partners of a first tier supplier. This does pose some requirements upon the data model however.

Starting point when documenting the supply network of a potential source, is that all organizations in the network are considered organizations linked through agreements on specific capabilities that are sourced from each other. The data model should be able to accommodate such statements as "Potential supplier A has outsourced the transport of the products X, Y and Z that they possibly will supply to us to their partner carrier B". In a specific mode therefore, data should be recorded on the items involved, the activity involved, and the source that is involved. The above has been summarized in Figure 8-6 (which is the same as Figure 7-5 discussed under Design Principle 2).

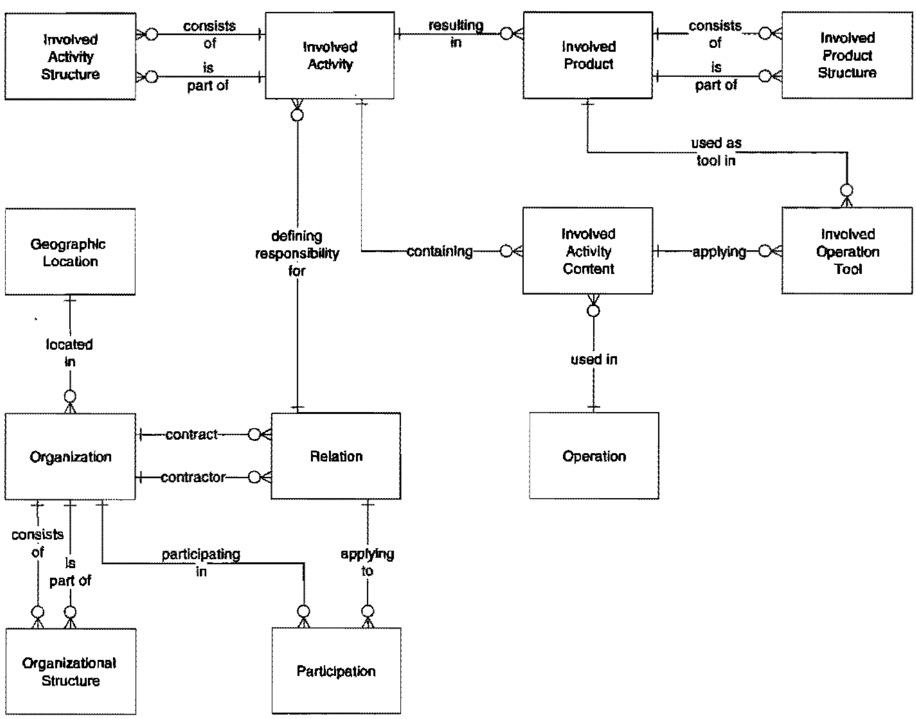

FIGURE 8-6. Detailed data model for modeling potential sources.

Data on Various Levels of Abstraction. A system that should be supportive to source selection processes has to be able to accommodate data on various, subsequent levels of detail. We need to be able to first record data that is supportive to the first steps of the process, where we might come across statements like "we have scanned the market place and we have come up with a regional contractor for the maintenance of our printing press", or "we have found a potential source, a large computer peripherals supplier, that might possibly supply us with a PC mouse". Later on during the process, however, these at first fairly abstract statements become more and more detailed until we need to be able to record specific details on the exact maintenance rates of that particular supplier, or on the exact specifications of the PC mouse. A sourcing system should therefore support different levels of abstraction which is supported by the generalization/specialization hierarchies of the generic object models discussed under Design Principle 3 in Chapter 7.

Generic Support for Checklists. An important point of attention is the ability of any sourcing system to accommodate a large variety in the type of data that is collected in the course of the process. If a distributor of a standard item is to be sourced, different data will most probably be collected than when a contractor is required for the design and manufacturing of a PMSN specific and critical IC. This was already identified under Design Principle 4 in Chapter 7.

Furthermore, during the source selection process, the type of data that is required can change, i.e., new requirements can be added, and others eliminated. The fact that we call these types of data 'requirements', serves an important purpose. We are now not discussing the need to be able to record data specific to a potential source as we have done until now, but the need to be able to alter *what about* a potential source we want to record. This implies that we need a system of which the data base definition can be easily and intuitively changed (see Design Principle 5 in Chapter 7, in which we discussed the need for 'purchasing by wire').

Both requirements can be met at one stroke by providing generic support for the checklists used in sourcing. First, the diversity in checklists can be met by setting up the object generalization/specialization hierarchy of organizations, activities, and items in the state independent part of the system (referring to Design Principles 3 and 4). Related to the various classes of the objects, we can define the features that should be investigated of such a class. Furthermore, to support consistent rating of these features, we can also record the options for rating the features (see Figure 8-7, which is the same as Figure 7-9 discussed under Design Principles 4 and 5).

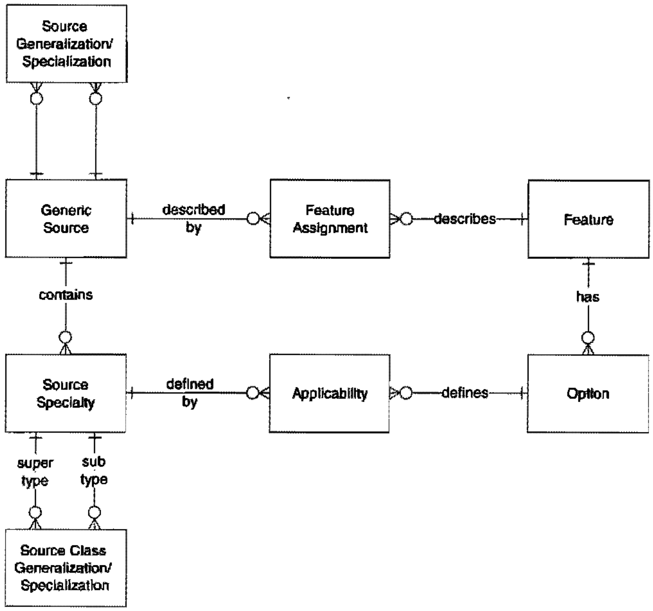

FIGURE 8-7. An example of the application of the generic object model in the state independent part of a sourcing system.

The data structure depicted above also enables us to document and confirm policies in actual sourcing processes, and to implement a link between policy and execution. For any instance of a generic object class, a policy can be defined by assigning the required features to this generic object class and assigning values to these features. Please note that customer requirements, organizational policies, sourcing policies, etc. all come together in the definition of features and feature values (options).

Now suppose a particular sourcing task starts, and that the required source in this project has been identified as a particular source class for which a policy (possibly including customer requirements) is available. The prescribed features then can be copied from the state independent part to the state dependent part of the system in order to support the specific sourcing task.

Furthermore, as multiple (intermediate) evaluations of the data found in the sourcing process take place, weightings or other indications of the relative importance of features might be incorporated into the policy specification. A Total Cost approach, however, is not supported by the foregoing.

The decision models that can be represented in the system can be considered 'mental' models, as the interpretation of the source data in the light of the final decision criteria is not carried out explicitly. That means that the source data are not explicitly evaluated on their relevance for future quality, or delivery performance, or — considering the use of the delivered product — on costs that will result from a particular source.

Without going in too much detail, the incorporation of the Total Cost approach would require an extension to the system. The state independent part should be expanded to accommodate data on the use of an item class (the life cycle phases or activities), the features of the item class that can be considered relevant cost drivers in these phases or activities, corresponding rates, and accounting rules that link cost drivers and rates. This knowledge can subsequently be used for calculating the costs related to a particular source. Still, as the case material also pointed out, these more advanced decision making practices are not often used or required as they are most often 'substituted' through the use of multi disciplinary teams. Furthermore, as it is an extremely complex task to provide a realistic Total Cost model, it is naive to think that the real effectiveness of the decision will be enhanced by using a complex model mostly based upon many assumptions and inaccurate accounting rules. It is more wise to use a more simple model, and a system that enables the analysis of various scenario's.

To satisfy the second important requirement upon a sourcing system, viz., the required 'real time' responsiveness supportive to the concept of 'purchasing by wire', a similar generic structure can be used. The flexibility is of course related to the features that are defined in the state dependent part of the system. When new features are distinguished during the process that are thought to be relevant, these need to be incorporated in the state dependent part of the system for documenting specific sources. If a particular feature is come across in many cases of a particular class, such a feature might be copied to the state independent part of the system so that it can be used in future cases as part of the policy.

Access and Request Capabilities. First, from the discussion and analysis of the interview results it has become clear that providing access to data and documents, wherever residing, whatever format, and possibly of a multimedia nature, is one of the most prominent requirements a supportive system should satisfy. The availability of various communication facilities and groupware functionality is therefore of primary importance in a sourcing system. A point of attention, however, is the possibility of recording all of these data in a structured way. This is generally required to be able to use these data in structured analysis and simulation tools. At the same time, however, the case material as well as the need survey indicated that extensive and advanced use of the obtained data hardly ever took place and was also even not immediately required. Most of the required analytical and sound decision making skills were thought to be implemented through the use of multi disciplinary teams.

Secondly, providing functionality to access information that is not recorded in any way or form yet, or that is not accessible to the people involved in decision making, should be a substantial part of any supportive system (e.g., through the use of a variety of requests). Scheer also noticed that supplier offers (as he calls them) are one of the most important instruments for filling the primary data of a purchasing system. Although his field of vision was somewhat narrow for our purposes, Scheer did correctly indicate the role of a document such as a request for quotation (or RfQ). It is nothing more (or less) than one out of many possible instruments that can be used in obtaining necessary data on potential sources. There are, however, two major drawbacks to the approach that he and many others — considering the typical design of current ERP systems — took, when implementing documents such as quotations as data sets.

First, this 'hardwired' approach does not allow for differentiating between specific documents that are used for different types of goods and suppliers, neither for styles of different organizations and buyers. Therefore, most of the current systems, if at all, only offer a rigid inquiry instrument that only contains the common divisor of the contents of RfQ's that can be encountered in industry.

Second, the approach passes over our finding that it is not wise to implement documents as a part of a system supportive to the tasks of a specific domain like purchasing (see Chapter 7). It was suggested in Chapter 7 that it is more sensible to use already available document management functionality as an interface layer between managerial support systems and specific purchasing systems. The specific purchasing data itself should reside in the domain specific layer. In that way, the looks and composition of any document can be changed independently of the content, which underlines the idea that a document (just as much as a screen) permits the interested party to have a customized view upon the data.

Because of the foregoing, the documents that are normally expected in systems supportive to decision making in purchasing (or in any other administrative environment for this reason) were not implemented as data sets in the prototype system, but as documents at the document layer.

Generic Purchasing Management Capabilities. A last point of attention that we want to discuss, is the finding that all sourcing processes were found to be of a similar structure, but at the same time differ from each other in details. This result shows many similarities with the characteristics of the diversity of products that can be represented with the Generic Bill of Material (GBOM) (see Chapter 7, Design Principle 4).

We therefore have to define a 'process family' for the source selection process. The generic process can be decomposed just like a product thus forming the generic process structure or generic 'bill of activities' (BOA). At the intermediate levels of the generic BOA the generic activities can be found; at the lowest level of the generic BOA the generic primary activities (GPA) can be found. The concept is similar to the GBOM.

The use of the GBOA for documenting source selection processes offers us many opportunities, particularly for configuring and generating a feasible sourcing process for a particular case. Analogous to its use for products, a configurator can support the identification of a variant of the sourcing process. A generator then can produce the specific list of activities based upon the identification provided by the configurator. The process configurator thereby has to support the choice of specialties at various levels in the GBOA until a valid variant has been identified. This can be done by guiding the user through the decision tree, based upon relevant case characteristics. Then, when a specific variant has been identified, this identification can be used for generating a specific BOA.

The details of this approach are discussed in the next chapter, as the priorities established through the need survey were not directly related to providing managerial support. We do, however, want to indicate the opportunities that exist for adopting the GBOM for processes in general.

THE PROTOTYPE

In this section we briefly discuss the prototype that developed during the project. Prototyping is an approach that was introduced for two reasons. First, the traditional modeling techniques as we used them until now lack a good language for communicating the functional specifications between developer and end users. This is of course a major disadvantage when evaluating the suitability of the design principles underlying the perceived system. Prototyping is an approach that is characterized by, a.o., the extensive use of working models as a means for communication between developers and end users (e.g., during evaluation). Prototyping thus tries to improve the effectiveness of the development process. For this specific prototype, a 'two phase' evaluation took place. First, the prototype was evaluated by the people from Philips Medical Systems that participated in the study. Second, the prototype was evaluated by the people attending one of the workshops that was organized at Eindhoven University of Technology.

Second, the traditional analysis methods insufficiently anticipate the evolution in information needs when end users gain experience with information systems. The prototyping approach, due to its iterative nature, is supportive to the learning experiences of end users. These experiences can then be taken into account when developing and building an actual system for operational use.

Because of this specific role of the prototype in the project, we only briefly discuss its characteristics and then proceed with the evaluations that took place.

The S^3 Prototype

Focus and Limitations. In building the prototype of the source selection system (which was abbreviated S^3), the focus has been on providing support for flexible sourcing. This was inspired by the need survey that was carried out. Together with the limited capacity in building the prototype and the time that was available, this meant that not all of the identified functionality is implemented in the prototype. The prototype supports (1) the definition of data for initial purchasing, however, not for purchasing management activities (Design Principle 1), (2) the definition of the major data sets (the 'backbone') required in sourcing, (3) the state dependent and state independent definition of sourcing policies resp. specific sources (Design Principle 3), (4) the definition and use of divers and adaptable checklists by making use of the proposed generic object model (Design Principles 4 and 5).

Monitoring capabilities, and the GBOA concept, however, are not implemented in the prototype. Also, the prototype does not contain any communication facilities. The user interface of the prototype did not receive a lot of attention as the focus was on the representation of functionality.

Functionality. The functionality that the system provides consists of possibilities to define a case (a specification), based upon classes of sources, activities, and items. Based upon a selected class, the prototype can select the relevant features. Based upon the specification it is possible to query data sets on existing sources and items that comply with the specifications. This can be done on various levels of abstraction, i.e., it is possible to query the data sets on the full specification, or on class level. If any alternatives are identified in this way, it is possible to query the details on these particular sources (i.e., their particular features and values) (see Figure 8-8). If only an identification is available, correspondence data are provided.

FIGURE 8-8. Querying existing sources in the S^3 prototype.

Illustrative of the role of documents in the proposed architecture from Chapter 7, is the possibility to generate customized requests based upon part of the specification that is documented in the system. These documents are, however, not as such identified at the layer of the source selection system. The alternatives that are considered relevant are indicated as such for the particular case under consideration. The data that are collected during the process can be presented to the user as a relative and absolute comparison report to support (intermediate) decision making before moving to a new selection cycle.

Evaluation Results

Philips' Evaluation. At the evaluation session at Philips Medical Systems, c. 20 people were present representing the various disciplines that are involved in source selection processes. The issues that were raised during the session can be summarized as follows:

- *Integration.* It was felt that much of the data on potential sources and their capabilities is already available in some form. Especially the interfaces with existing systems used for parts and for vendor rating were discussed. From any source selection system it should be able to access data in these systems. Furthermore, in defining the specification that forms the basis of the process, it would be useful to provide interfaces to CAD models, and to be able to access engineering drawings. These interfaces also illustrate the architecture that was proposed in the previous chapter (see Figure 7-11), where a difference is made between the source of data, and the use thereof in a particular (possibly other) process through a document interface layer.
- *Data Access and Entry.* Although it was felt that source selection processes could benefit from the use of an actual operational system, it was also questioned where all the required data could be found (especially the initial identification of unknown sources), and subsequently, how the system could be 'filled' with that data. Automatic data entry would need attention because of the effort in manual data entry. An important criterion here is the need for structured data or not. If accessibility is the only requirement, document imaging, and document or file indexing might be a solution. Furthermore, the use of and access to external systems (like the Internet) was a topic of discussion.

- *Meaning of Data.* The data set used for documenting items has traditionally been used for both items and services. This was necessary as no explicit data set for activities is available in the 'traditional' systems. At the same time, however, this tradition might pose some problems, as the new structure proposed in this system is not yet settled down.
- *Validity of Data.* Data that is collected on sources should be checked on validity. Supplier's capabilities and characteristics change over time, and even at a faster pace than ever before. It is therefore necessary to timestamp most of the data that is collected in this way (and who gathered and recorded it) to give the future user the possibility to test the reliability and validity of the data.

The major benefits that could be derived from a system based upon the prototype (and thus the underlying design principles) can be summarized as follows:

- *Accessiblity.* The access to the type of data that could be accommodated in such a system was felt to be one of the biggest advantages over other systems. As other systems aim at the recording of the resulting data, this system aims at recording data during the initial source selection process. It was not perceived as a registrative application but as a tool to record and maintain supply market knowledge.
- *Consistency and Structure.* One of the most important potential advantages that was discussed during the session, was the structure that was brought into the critical source selection process. Therefore, effectiveness, consistency within and across cases, and transparency were thought to improve substantially through such a system.

Workshop Evaluation. During the workshop that was organized at Eindhoven University of Technology, purchasing professionals from other companies, consultants, and IT specialists commented the prototype. The issues that were raised during the workshop could be summarized as:

- *Integration.* Just as in the session at Philips Medical Systems, it was felt that much of the required data could be found in other systems, either internal or external of the company. Therefore it was again confirmed that integration wit other systems was of primary importance. Point of attention thereby also was the accommodation of unstructured (digital) documents or BLOB's ('big lumps of bits').

- *Location of Content.* For large organizations, it should be questioned where data that is collected should reside (decentral, central), and how data should be distributed over local systems. Connected to this question is the question of the responsibility for the content of the system, taking into account the changes that occur in the market place. Others in the market place probably also collect data on the same companies, and therefore it was felt that joint efforts by different plants (e.g., through a corporate purchasing function or lead buyer role) or even different companies could be made responsible for collecting and recording these data. Conceptually, the sources themselves are of course the best location for these data (compare this with many WWW sites of potential sources), although this implies that data will most probably be commercially biased and inconsistently structured. Furthermore, this type of data will also not always be suitable for the purpose of source selection, nor will it always be accessible in a structured way. The last characteristic might also hamper the initial identification of a potential source. The accessible data of course can also not be of any confidential or competitive nature. It should be noted that the role of content providers on the Internet and sources like business directories, Chambers of Commerce, and others also increases in importance in such a scenario.
- *Cost Focus.* In addition to the data that are related to the capabilities of a potential source, a source selection system should also enable to analyze the cost structure of a potential item. As we already indicated, such functionalities were not incorporated in the prototype, but are documented in Chapter 7 (see Design Principle 2). Benchmarking data and trend figures for raw materials can be of importance in the subsequent interpretation of these data. This indicates that it might be of importance to be able to specify benchmarking data for class level features in the state independent policy part of the data base. These benchmarking data can then be copied to the specification for a particular case. Monitoring capabilities for these benchmarking data were, however, not taken into account in the prototype. Furthermore, Total Cost techniques were discussed in a similar way as was done in this chapter.

The perceived benefits that were discussed during the workshop can be summarized as follows:

- *Search Power at Class Level.* The fact that the prototype enabled the registration of data on different levels of abstraction, and even more, to search for potential sources by using class level characteristics and ranges instead of point values, was perceived as a major benefit compared to existing systems.
- *Accessibility.* The access to data as can be accommodated in a system such as the prototype was found to be very valuable in making long lasting and important sourcing decisions.
- *Case Dependent Processes.* Although not explicitly built into the prototype, the perceived possibilities for generating case specific source selection processes based upon the GBOA concept, were very much valued.

Lessons Learned. From the evaluation two points are memorized. First, the need for integration with or access to multiple (external) systems, and connected to this issue, the questions in the field of data distribution (like content responsibility and providers, (im-)possibilities for structured use of the data, reliability, validity, etc.). Second, the major advantages that such a system could provide were the access to and search for data on different levels of abstraction, and related to sources not yet known, and the impetus of such a system for consistency, structure and transparency of the process in itself.

SUMMARY

This chapter described a project aimed at the detailing of some of the design directives that were described in Chapter 7. Furthermore, the practicability of the directives proposed in that chapter were evaluated in an industrial environment through the development and evaluation of a prototype supportive to source selection. A need survey illustrated the importance of flexibility in any supportive tool, which pointed out the need for a tool that could support the diversity of cases, and that accommodated an adaptable data base. After providing a detailed case illustration of such a source selection process, detailed requirements were developed based upon which the prototype was developed. Important aspects of a supportive system concerned the possibility to monitor possible events that might trigger the source selection process, to accommodate extensive supplier and supply network data on various levels of abstraction, to provide generic support for checklists, to provide support for access and requests for data, and to use the generic concept for generating case specific procedures for source selection. The subsequent evaluation of the prototype that partly addressed these aspects showed that integration with and access to other systems, and data distribution were important aspects in actual implementation. Furthermore, it was felt that the added value of the perceived system was in providing access to significant data in the source selection process, and the impetus that was expected from such a system on the consistency, structure and transparency of the process itself.

—9

A Prototype for Contracting

Account managers as well as functional department managers at Fokker Aircraft — the Dutch aircraft manufacturer and then subsidiary of Daimler-Benz' DASA — frequently inquired after the existence of specific contracts at the legal unit that was part of the purchasing department. If any contracts were in place for a specific contractor, questions about any details had to be answered by this legal unit. Examples hereof are questions about after sales clauses in the contract (for Product Support) and contract data required for effectively handling claims. Although the contract data were available within Fokker, it was felt that these were not accessible in an economical way, which obstructed the support of functional and account management on legal aspects. Furthermore, as a result of more strict business relationships with suppliers, the need for accessible contract data and 'fit for purpose' contracts intensified. When the old word processor was replaced (requiring format changes to contract documents) and a local area network (LAN) was implemented, the discussion was initiated concerning the development and implementation of possible new functionalities supportive to contracting.

CHAPTER CONTENTS

The opportunity described in the introduction of this chapter was seized to start up a project aimed at the definition of functional specifications of a contracting system. From the viewpoint of the research this was a second opportunity to detail the directives discussed in Chapter 7 and to evaluate their usefulness and practicability. Again this was done through the development of a prototype system, however, now supportive to contracting during sourcing. Before going into the details of the project, we first provide the reader with some additional background information to the project.

BACKGROUND TO THE PROJECT

The major problem that was identified was that of the inability to get quick and accurate answers to relatively simple ad hoc requests of, a.o., account managers about contracts within Fokker Aircraft. Accessibility therefore for a long time has been a primary requirement for a system supportive to contract management. Several initiatives were identified addressing this accessibility of contract data, as well as some other aspects related to contracting.

Previous Initiatives

A first and initial initiative was aimed at improving the availability of contract data by introducing a contract numbering system. Sequential contract numbers were assigned by a secretary when filing the contract. This contract code further made reference to the type of document within the overall document structure. These contract codes were maintained manually in a copybook. This initiative was succeeded by a proposal for the automated issue and maintenance of contract numbers on a PC. The proposal also included a number of classifying data elements for use in contract document retrieval. The proposal, however, was never actually realized.

Another initiative was aimed at supporting the legal unit of the purchasing department in conceiving new contracts. A document was therefore prepared that identified the contract types that were used within Fokker Aircraft and their possible reasons for application. Whereas the other initiatives were aimed specifically at the accessibility of contract documents, this particular initiative specifically aimed at supporting contracting itself.

Related Initiatives

Other projects that were related specifically to contract management were projects addressing the management of performance during the recurring activities carried out by suppliers and contractors. It was stressed that contract data can be used as a yardstick to evaluate performance data.

Contract data cover the targets that have to be achieved by suppliers, and these are therefore also considered the responsibility of account managers.

There also had been an initiative in the field of contract management in the Product Support directorate of Fokker Aircraft. This initiative had already lead to an operational system supportive to contract management for the services that Fokker provides its airline customers. This system was mainly used for keeping track of the commitments Fokker had made to its customers (e.g., in the area of documentation, training, initial spares, etc.), and to assure their timely completion.

Specification of a System for Contracting

It was already indicated that a situation existed in which a system supportive to contracting could prove to be cost effective. The project that is discussed in this chapter thereby aimed at the delivery of detailed specifications of such a system. Again, this was done through the development of a prototype system.

In detailing the knowledge on contracting, organizational policies and documents were analyzed, several interviews were carried out focusing on the contracting process, and many contract documents were analyzed to gain insight in their content and structure.

Analogous to the approach discussed in the previous chapter, use was made of the prototyping approach thus primarily enabling a more effective evaluation of the specifications.

Before we report on the results of the interviews and the resulting prototype design, we now first report on Fokker Aircraft's approach to contracting.

CONTRACTING IN FOKKER PERSPECTIVE

Fokker's Organizational Policies on Contracting

The general starting points on contracting and related purchasing activities are documented in the Fokker's organizational policy handbooks. Main points that we want to address here is the distinction that Fokker makes between the determination of needs and specifications (in which purchasing has a supportive and advisory role), and the primary purchasing function of satisfying these needs. The purchasing function of satisfying the specified needs is again subdivided into a non recurring sourcing process, and a recurring procurement process. Contracting, together with the functions of qualification and selection, is considered to be part of the non recurring sourcing process. Qualification, selection and contracting are considered to take place in parallel with each other, with the main aim to provide Fokker with a 'pool' of contracted suppliers (see Figure 9-1).

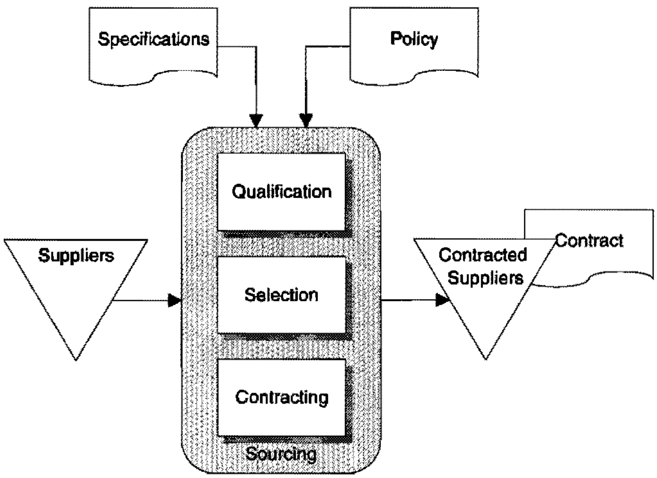

FIGURE 9-1. Qualification, selection and contracting in the Fokker sourcing process.

Contracting thereby includes the negotiations with third parties and the putting down of the intermediate and resulting binding agreements in writing (in general, this is the General Terms of Agreement — the GTA — including possible exhibits). It should be noted that not such formal contracts can contain binding agreements as well and that a limited number of people, defined in a list of attorneys, can sign documents containing such binding agreements. Signing such documents is governed by an authorization procedure. After signing, the original contracts are sent to the Corporate Legal department at Fokker's head office; a copy remains at the account manager and relevant parts are distributed to the functional departments involved. In general, contracting is the responsibility of an account manager, supported by legal specialists. *Qualification* involves the evaluation of the supplier's quality assurance systems, an audit of the supplier's processes, and the first series inspection. *Selection* involves defining a bidders list, requesting, clarifying and evaluating proposals of suppliers, recommending suppliers to the Supplier Selection Board based upon the proposals, and finally the decision and authorization thereof by the SSB.

CONTRACTING — ANALYSIS AND REQUIREMENTS

During the project, the contracting activities and their interfaces with the other sourcing activities were investigated in more detail. This was done through several interviews with buyers, account managers, legal consultants, organizational support staff, and management. In the following section we discuss the results of these interviews.

Contracting Activities

Prepare Request Annex. The contracting part of the sourcing process generally starts when a bidders list is available. Depending upon the case, primarily defined by the requirements specification (including the definition of the supplier's work share) and the type of supplier, a contractual annex has to be appended to the formal request for proposal (RfP). A first important activity therefore involves the determination of the type of situation concerned, and the subsequent definition of an appropriate contractual annex containing commercial and legal conditions. There are several standard annexes available pertaining to specifically defined situations. Next to this annex, it might also be necessary to append a non disclosure agreement (an NDA) if confidential information is part of the RfP. Such an NDA might also already be used before a formal RfP is sent out, namely, when an early Request for Information (RfI) is sent out that contains confidential information.

It is clear that such activities are closely integrated with the selection and qualification activities that were already discussed in detail in the previous chapter.

Ascertain Proposals. When the sourcing process has arrived at a point in time that more formal and detailed information is required on the proposals of the then remaining sources, negotiations with these sources take place. This is closely related to the activities aimed at the collection of data that were already identified in the previous chapter. When we decide that the actual data collection activity is part of the selection activity, contracting specifically aims at the clarification of part of the collected data (mainly from a legal point of view). Therefore, explanations are asked for on specific topics of proposals, suggestions are made to improve and clarify the proposals, etc. This activity might result in revised proposals. Depending upon the value involved in the contract together with the perceived risks, it may occur that (parts of) the intermediate proposals are put down in writing as a formal, binding agreement. This may result in documents such as a Letter of Intent (LoI), a Memorandum of Understanding (MoU), or a Memorandum of Agreement (MoA).

Again, these specific contracting activities are considered to be an integral part of the sourcing process as a whole.

Agree Contract. After the selection of a supplier based upon the final and possibly revised proposals, the exact contents of the agreements are negotiated with the supplier. Based upon the results of these negotiations it is possible that the selection decision is revoked and that the negotiations with other suppliers are reopened.

The negotiations ultimately result in a GTA, the definitive agreements. In principle, a GTA is agreed upon with every supplier, including the required exhibits. These negotiated agreements are then recorded in the definitive and specific contract based upon the earlier contract standard. It then is subject to contract management.

Contract Management. Within the conditions of the contract the activities that were outsourced are carried out. Concurrently, the contract is continuously monitored and evaluated to test the topicality and usefulness of the agreements, taking into account changes in the supply market or specifications, and performance results. Furthermore, the expiration date of the contract is of course relevant in contract management. These evaluations can lead to, e.g., reopening contract negotiations, contract revisions or renewals, or even the decision not to work with the concerned supplier anymore.

The foregoing has been summarized in Figure 9-2.

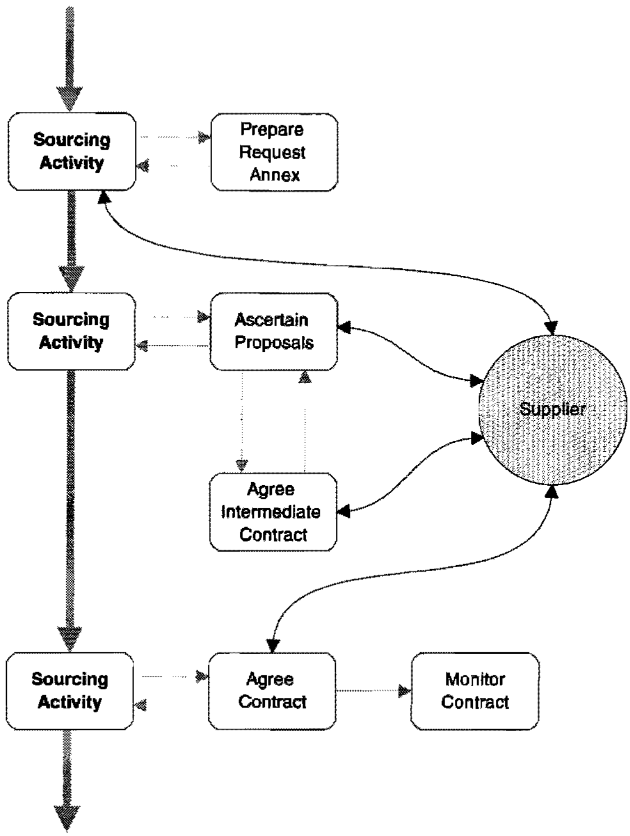

FIGURE 9-2. Contracting activities during the sourcing process.

Contracting Documents

A very important aspect of contracting is the use and importance of documents in the activities. In the process, initial standard contracts are used, and subsequently these are changed, and finally their resulting specific contents agreed and documented.

Standard Documents. Within Fokker Aircraft, 54 contract types (also referred to as standards or INK's) exist of which 14 types are frequently used and considered most important. These standard contract types are subdivided into contracts for suppliers, contracts for subcontractors, and general documents (like the NDA). Other documents that play a role are the already discussed RfI, RfP, LoI, MoU, and MoA. Furthermore, many other documents are used for, e.g., contract details and summaries, contract changes, and for authorization and distribution of contract documents.

The most important contract document is the GTA including its exhibits. The GTA is a modular document consisting of a general part, exhibit A (specification), four types of exhibit B (quality) and two types of exhibit C (product support). The general part of the GTA is the responsibility of the account manager, supported by the legal advisors. This general part of the GTA can be over a 100 pages long. The exhibits are the responsibility of the corresponding departments.

Specific Documents. Based upon the initial standard contracts, specific contracts tailored to the situation are defined. These specific contracts are coded with a sequence number. Some 1,000 of these specific contracts are in place.

Discussion and Analysis

As the focus in this research is on initial purchasing, we focus our analysis on the contracting activities that are carried out during sourcing. Contract management activities are therefore not taken into account any further.

Documents and Data. As we have seen, documents play an important role in the process. As we also already indicated in the previous two chapters, documents can also be considered an instrument, that permits the interested party to have a customized view upon purchasing specific data. A specific problem related to the management of the data in the context of contracting is the fact that most data in the documents involved are not structured data, but mostly texts that include some specific (structured) elements such as dates, supplier name, specifications, etc. This can be compared to the data that normally has to be filled out in documents at the so called 'dotted lines'. The other texts hardly ever change, but typical documents for typical situations do exist.

At this place it is also useful to distinguish between the management of state independent standard contracts or so called contract templates, and the management of state dependent specific contracts with specific suppliers that are possibly based upon these standard contracts.

Document Structure. Another thing that was found was the observation that most of the longer and more complex documents consisted of document parts, i.e., documents had an explicit structure (like this book has a structure reflected in its Table of Contents). An example is the GTA that consisted of a general part (that in its own turn consisted of lower level sections and even lower level clauses and sub clauses), and several exhibits. Furthermore, it was found that many of the document parts at the lowest levels were also used or reused in other documents. For instance, a clause on 'Prices and Payment' that can be found in more than one standard contract.

Defining Documents. An important point of attention that was already briefly touched upon when discussing the previous points, is that when documents are defined, most of the data (in particular texts) are copied from a standard template. The template to be used is thereby identified through an evaluation of the characteristics of the situation. In general, only the structured elements then need to be specified as they are specific to the case. Texts only occasionally need to be changed and clauses from other standard contracts are also sometimes used.

An important aspect related to this is the fact that if, for any reason, legal texts need to be changed, it is a necessity to know where specific texts have been used. Only then these can be updated (this is sometimes referred to as 'change synchronization').

Documents and their Life Cycle. Documents (as well as their parts) can be considered as having a 'life cycle'. Documents pass through several stages and they can be assigned a status accordingly. Documents are defined, authorized, multiplied (so, copies of documents may exist), distributed, stored, revised/changed (i.e., versions of documents and their parts may exist) and ultimately deleted (see Figure 9-3).

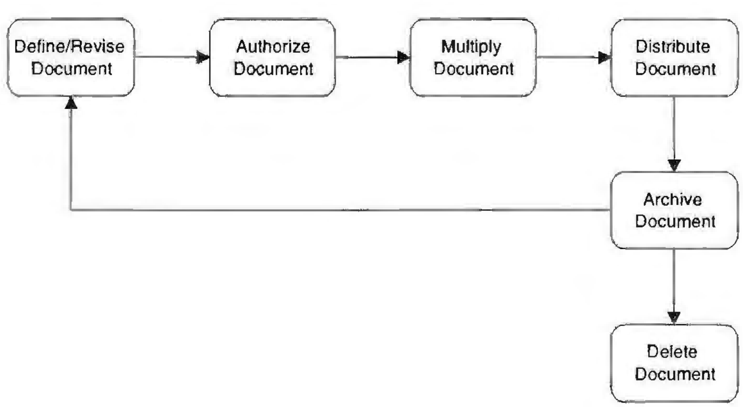

FIGURE 9-3. The document life cycle.

Documents and Dossiers. Another important remark is that it should be noted that binding agreements are not only documented in GTA's, but can also be defined in other documents like LoI's, RfP's, MoU's, MoA's, letters, telefaxes, and other correspondence between a supplier and Fokker Aircraft. Therefore, in a broader sense, a system should be able to support the management of all kinds of documents related to a relationship with a supplier. Therefore the notion of 'dossier management' was introduced that was considered to be more supportive to the account manager's job.

Implications for IT

Generic Document Management Capabilities. The standard contract documents are all of a similar structure, but differ with respect to their lowest level texts (i.e., whether a clause is represented in a specific type of contract or not, and if so, what specific variant of that clause). Again, this shows many similarities with the characteristics of the diversity of products that can be represented with the Generic Bill of Material (GBOM) (see Chapter 7, Design Principle 4). Many of the aspects identified in the previous discussion can therefore again be addressed by adopting a generic approach.

Analogous to the discussion on the Generic Bill of Activities (GBOA) in the previous chapter, we now have to define a 'document family' for contracts. This generic contract can then be decomposed just like a product thus forming the generic document structure or generic 'table of contents' (GTOC). At the intermediate levels of the GTOC the generic document parts can be found; at the lowest level of the GTOC the generic primary document parts (GPD) can be found that actually contain the texts. The GTOC concept is thus similar to the GBOM. This generic contract is recorded in the state independent part of the system (including the standard texts) (Chapter 7, Design Principle 3).

Again, the use of the GTOC for contracts offers us many opportunities, particularly for configuring and generating a feasible contract for a particular case. Analogous to its use for products, a configurator can support the identification of a variant of the contract. The contract configurator thereby has to support the choice of specialties at various levels in the GTOC until a valid variant has been identified. This can be done by guiding the user through the document structure and choice tree for specific variants at each level and branch of the GTOC. This is done through the use of features and values. Through the specification of a combination of values on these features (i.e., defining the case under consideration), a suitable contract can be configured (see Figure 9-4).

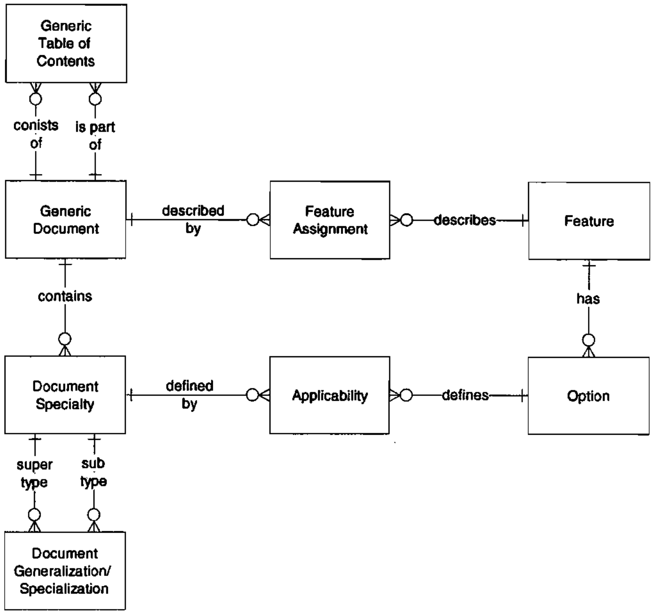

FIGURE 9-4. State independent representation of a generic document. *Source*: adapted from Hegge, 1995, p. 77

After specifying a number of feature values (or options) a specific standard contract for the specific type of case is identified. The structured data that are really specific to the actual case have not been recorded yet however. Therefore, in GBOM terms, a standard contract is not yet a specific variant, but a set of variants (a specialty) that yet has to be specified through the structured 'dotted line' elements in the document. These 'dotted line' elements can thus also be considered as features that have to be given a specific value in the actual contracting activities. In this way the specialty is further narrowed down, through specifying the 'dotted line' elements belonging to some of the GPD's until the contract is completed.

A generator then can produce the specific table of contents (including texts) based upon the identification provided by the configurator. This contract can then be recorded in the state dependent part of the system, and linked to the case under consideration.

Furthermore, the text of GPD's itself may possibly be changed so that case specific variants of the text may come into the picture (possibly including new 'dotted line' elements). All these specific elements have to be recorded in the state dependent part of the system.

Status, Version and Copy Control. Other specific problems are related to the fact that different versions of documents (and their parts) may exist, that these versions may be in process (thus having a specific status), and that copies of them may be present in different places.

For versions, three things have to be considered as in practice a 'version' may be quite similar to a variant. First, there might be several 'versions' of the 'Prices and Payment' clause for different purposes. If this is the case, we will not identify this as a version, but as a variant. This can be supported by the generic approach already discussed before.

Second, there might be a specific 'version' of a standard variant, that is used specifically for a case. This can also be handled in the way that was already discussed, as such a 'version' is a case specific variant that is recorded in the state dependent part of the system. The only thing that should be considered here is that when copying the standard variant for use in a specific situation to the state dependent part of the system (after configuration), a link to the state independent variant is maintained. This enables us to identify the standard contract a specific contract is derived from (which might be important when, for instance, changes in standard texts occur). Again, we won't consider this to be a version, but a variant.

Finally, a variant — whether state dependent or state independent — may change over time, however, without its application changing (which might indicate the need for new variant instead of a new version). This is what we consider a version. These versions need to be recorded specifically, as a specific contract might, for instance, be derived from a specific version of a standard variant (therefore, this also needs to be recorded when copying a configured contract to the state dependent part of the system). Furthermore, specific versions of a state dependent and case specific variant also need to be recorded, as agreements with a specific supplier might change over time.

This last topic, that of actual versions, brings us to the management of copies of a contract. If changes have to be made, copies that exist of a version of a document (or part thereof) need to be updated. We already briefly discussed this when introducing the concept of 'change synchronization'. Although copies are different from derived variants, both need to be updated when changes occur. How this can be done for variants was already discussed before. To synchronize copies, it needs to be documented who has a copy of a specific document in its possession and where these copies reside. A change procedure (including authorization, distribution, and notification) is, however, part of the managerial layer of any support system.

The status of a specific version of a document[1] is closely related to the process of defining (or revising) that document. We therefore consider the status of a document to be changed in the process (so, through the managerial layer). The process of defining and revising a document therefore needs to be analyzed and documented in the managerial layer of the system. Again, it may be required to be able to change the status of a part of a document.

THE PROTOTYPE

In this section we briefly discuss the prototype that developed during the project. The prototyping approach was introduced for the same reasons that were already discussed in the previous chapter, viz., to enable more effective communication between developers and end users, particularly during evaluation. Again a 'two phase' evaluation took place. First, the prototype was evaluated by the people from Fokker Aircraft. Second, the prototype was evaluated by the people attending one of the workshops that was organized at Eindhoven University of Technology.

The PCSS Prototype

Focus and Limitations. In building the prototype of the Procurement Contracting Support System (PCSS), the focus was on providing support for contract configuration. Although many of the issues concerned the availability and accessibility of contract data, this choice was inspired by our focus on initial purchasing activities. Furthermore, accessibility and availability issues should be dealt with and based upon a (generic) structure as was proposed in this chapter. First, we therefore have to evaluate the suitability of such an approach.

Because of the foregoing, we focused on restructuring existing contracts according to the GTOC concept, and providing support for the state independent storage thereof. Furthermore, we focused on the configuration of contracts. Support on the managerial layer was not addressed. Like the S^3

[1] This implies that a status of a document pertains to a specific version of a variant of (a part of) a document.

prototype, the PCSS prototype did not contain any communication facilities and its user interface was also not consciously designed.

Functionality. The functionality that the system provided consisted of possibilities to define a state independent document family (a generic contract), where contract texts are implemented at the lowest level of the GTOC. These texts are implemented as a word processor file enabling normal, user friendly editing of texts. Furthermore, the PCSS prototype system guides the user through the document structure and decision tree in the configuration of a contract (see Figure 9-5). This was done through the use of features and corresponding values that are representative of the case. Specific 'dotted line' elements were also implemented as features of a particular GPD (next to case characteristics).

FIGURE 9-5. Traversing through the document structure and choice tree of a GTA (including a link with a word processor) in the PCSS prototype.

Evaluation Results

Fokker's Evaluation. At the evaluation session at Fokker Aircraft, c. 15 people were present, mostly buyers, account managers, organizational staff, legal specialists and management. The issues that were made during the session could be summarized as follows:

- *Pre-Implementation Efforts.* Although most of those present were convinced of the benefits of the system, it was also clear that before any real operational system could be implemented, documents and processes would need to be reengineered. Standard documents required restructuring, version control needed to be implemented at part level, etc. However, despite these significant efforts, Fokker Aircraft decided to continue this approach.
- *Integration.* Another, somewhat more technical issue was also discussed extensively. This issue was related to the 'dotted line' elements. Most of these elements concerned structured data like supplier names, etc. that were also present in other systems. Integration therefore was a key issue. However, this appeared to be not a very straightforward issue. Most important problem here was the fact that whereas a supplier name is normally a field (an attribute type) of a supplier data set, in the PCSS the supplier name is a feature (i.e., a record in the feature data set). So, traditional systems are mostly implemented at a lower level of abstraction. At the current state of affairs this difference in abstraction level can only procedurally be met. Of course, if such a system needs to be integrated with the generic sourcing systems discussed in Chapter 8, where supplier names are also implemented as features of a supplier, this difference is nullified.

The major advantage that could be gained from a system based upon the prototype and its underlying design principles can be summarized as follows:

- *Support through Legal Knowledge.* In general, people were convinced of the benefit of such a system. If the system was capable of accommodating legal knowledge about the applicability of specific clauses, fairly obvious cases could be handled independently by account managers, without legal support. Of course this resulted in a discussion about the role of the legal specialists. Clearly, their role would shift from configuring fairly obvious contracts to contracts for exceptional cases (which can be compared to an 'engineer-to-order' situation).

Workshop Evaluation. During the workshop that was organized at Eindhoven University of Technology, purchasing professionals from other companies, consultants, and IT specialists commented the prototype. The remarks that were made during the workshop can be summarized as:

- *Integration.* Again the issue of integration was raised, thereby mainly focusing on the integration with other systems through the use of the structured data in documents. Specifically, the link with detailed specifications of the items that are normally also part of the contract (as an enclosure) was discussed. Usually, these parts of the contract make up the largest part of a contract. The proposition is, however, that these documents can also be handled in the same manner, although more structured elements will be present in these document parts. Also, these structured elements will normally be accommodated in product development tools as indicated in Chapter 7. The fact that the proposed system is on a higher level of abstraction also posed some problems in discussing the design at all.
- *Knowledge Representation.* Another topic of discussion was related to the fact that the use of template documents or document building blocks in fact was nothing new. The type of use of these templates and building blocks as was proposed in this chapter, however, does differ from the ordinary way of using templates, as the system also accommodates the knowledge on when to use a particular document. Furthermore, the proposed design also meets many of the problems normally related to the use of documents like version control. The issue of knowledge representation also lead to some questions regarding the role of a software vendor. Traditional systems require the exact definition of files (including the features). The proposed approach does not require this, as user organizations themselves are allowed to define features. In addition to the generic support that software vendors can provide in the field of workflow and document management, software vendors can also provide additional support by providing a set of features to use in purchasing, or even a set of standard contracts and their applicability (especially for smaller organizations this might be

helpful). Therefore, software vendors need to analyze, for instance, their installed base to build up this type of knowledge.

Lessons Learned. From the evaluations it was clear that the possibility of accommodating contracting knowledge was perceived as being the major advantage of the proposed system. To harvest these benefits, however, considerable pre-implementation efforts are required in restructuring documents and processes, and in discovering and representing applicability rules. Furthermore, it was clear that the integration with systems, particularly those that accommodate the structured data used in the documents, requires additional attention. Although this integration is not impossible at this moment, adopting a generic approach in other tools would certainly facilitate this integration.

SUMMARY

Like the previous chapter, this chapter also focused on the detailing and evaluating the practicability of some of the design directives proposed in Chapter 7. This was done through the development of a prototype of a system for contracting. Based upon an analysis of contracting activities and documents — pointing out the suitability of the generic bill of materials concept for configuring documents — a system was designed. Subsequently the prototype was developed and evaluated. From the evaluation it turned out that contracting could benefit from the use of a system based upon the specifications, particularly through the possibility of accommodating applicability rules for contracts. Pre-implementation efforts are, however, required to harvest these potential benefits. Integration, finally, remains an issue to pay attention to, especially the manner in which the different levels of abstraction that were identified can be integrated.

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Conclusions and Evaluation

Two forces — changes in business, and changes in technology — will have a major impact on the computer systems purchasing uses in the 21st century. Changes in business in recent years have been led by the thrust of synchronous processing in both design and manufacturing and by the pursuit of quality. These changes have resulted in shifts in the way the job of purchasing is done. And they also have resulted in a need for new and better systems. Meanwhile, the technology — particularly in the form of computer and communications capabilities — continues to significantly outpace businesses' ability to use it effectively. In purchasing, exciting advances will continue to stretch the function's ability to define high-value applications of the technology (*Source*: Porter, 1993, pp. 32, 42).

CHAPTER CONTENTS

In the final chapter of this study the objectives posed at the beginning of our study are recapped and the major lessons that were learned are summarized. These lessons — where possible — are summarized in design directives that can be used in the referential strategy that was outlined in Chapter 1. This chapter then continues with discussing the contributions of this study to the advancement in the fields of both purchasing and information technology. Finally, some recommendations for further research and some concluding thoughts are provided. First, however, we start with a brief recapitulation.

RECAPITULATION

In Chapter 1 the challenge of this research was phrased as to increase the currently existing knowledge on the effective use of IT in contemporary industrial purchasing. As purchasing has undergone significant changes over the last few decades, it was expected that the IT tools used to support purchasing would need to be enhanced as well. The purpose was to gain knowledge on both currently existing applications of IT and on any new and more effective applications of IT in industrial purchasing. The central question in this research therefore was what IT functionality is required and can be applied to effectively support contemporary industrial purchasing.

To answer this central question, several sub questions have been answered first. These questions concerned the state-of-the-art in IT application in purchasing, the purchasing tasks or decisions that require IT support and their corresponding processes, and the typical purchasing situations that can be identified in the industrial purchasing practice. The answering of these research questions yielded a detailed insight in the areas that require support from IT and the requirements that should be satisfied by IT in these areas. This led to a set of design directives for use in developing information systems for initial purchasing. The research then continued aiming at the detailing and evaluation of these directives in an industrial environment. This was done through a prototyping approach including a 'two phase' evaluation.

The major lessons that were learned through answering the research questions, and the subsequent detailing and evaluation of the resulting knowledge, are summarized in the next section.

CONCLUSIONS AND DIRECTIVES

In the following sections the major conclusions resulting from the research are summarized based upon the reported results in this dissertation. Additionally, based upon these conclusions recommendations are provided in the form of directives. These recommendations can be used in the design and selection of information technology for initial purchasing in industry.

The conclusions are organized according to the chapters in this dissertation.

Typical Support is Limited to Operational Purchasing Tasks

Historical Overview. Over the last three decades, IT has almost fully penetrated industrial purchasing. The use of IT thereby evolved from automating the clerical and administrative tasks of the buyer (in the sixties), to management reporting and integration with production planning (in the seventies), to decision support and communication (during the eighties). The nineties, finally, showed the emergence of many new technologies like the Internet and Groupware applications, the application of which is only at the beginning.

It also showed that although the use of some advanced applications was reported in the literature, the common use of IT in industrial practice is limited to the application of standard ERP (Enterprise Resource Planning) packages supporting routine requisitioning, ordering, expediting, and administrative tasks.

Reasons for this state of affairs were found to be the efficiency focus in applying IT, purchasing's perceived added value, its process characteristics, and a lack of mutual understanding between purchasing and IT professionals.

Directives that result from the foregoing can be summarized as follows:

1. In developing the functional specifications for a system supportive to (industrial) purchasing, *make use of already existing knowledge*; a lot already has been done! Especially if you are in an early state of IT application in purchasing, it is not necessary to re-invent the wheel! Please note that most of the available standard software packages thereby usually only represent a small, but possibly sufficient portion of functionalities to support your operational needs. The only thing to watch out for is the emergence of the 'not invented here'-syndrome.
2. *Keep track of new applications of information technology*, as the advancements made in this technology (and its application) probably outpace your ability to come up with applications, let alone new technologies. This enables you to become aware of and benefit from developments before your competitors do.
3. In justifying any new and more advanced applications of information technology in purchasing, *focus on potential benefits pertaining to the effectiveness and added value of purchasing*.
4. The advancement in the application of IT in purchasing would benefit from an increased mutual understanding between IT and

purchasing professionals. Therefore, we recommend to *improve the education and training* of both IT- and purchasing professionals, and to incorporate more knowledge on purchasing respectively IT in these programs.

Standard Software. Our study showed that the typical use of IT in industrial practice is limited to the application of standard ERP packages. These ERP packages mainly address the purchasing of goods for stock. These goods generally are simple, standard and encoded items that are required in the production or assembly operations. The procurement of complex products that are attended with ample specifications is less well supported by the existing software. The required functionality to purchase customer order specific items — requiring relations with purchasing requisitions in other modules (Production, Planning or Sales) — is not always available or only limited. For the outsourcing of production activities only limited support is available concerning the registration of items to be produced externally, materials to be supplied (from stock, internally produced or purchased), and the issue of materials to the supplier. Outsourcing is mostly considered a stepchild and is not very well supported (or even not all).

Directives that result from the foregoing can be summarized as follows:

1. Before software can be selected you have to *become aware of the purchasing practices in your own company*. Furthermore, as this description has to be purposeful in the light of the subsequent selection, this implies that you have to model and define your practices in the terms of ERP packages (i.e., in terms of transactions and data).
2. If software is to be selected and the discussion has narrowed down to the choice between several standard ERP packages, *be aware of the limitations of these packages*. Focus on requirements that may make a difference, not on requirements that no package can satisfy as this will not serve the purpose of discriminating between them. Some of these discriminatory features have been provided in this study.

Reference Models. During the study, several reference models for purchasing were identified, described and evaluated. Although these models differ in their level of detail, they all identify purchasing activities like the registration of primary data, ordering, order monitoring, goods receiving, inspecting and issuing, and the settling of financial accounts (invoice checking and payment authorization). Differences occur when looking at the origin of the demand. Some models focus on requirements arising from MRP or stock replenishments, others focus on individual requisitions. Furthermore, less typical are possibilities for recording quotations, complex supplier structures, item classes, and a separate purchasing BOM, and the support of multi site purchasing.

Another conclusion was that the reference models have primarily been developed for use in production oriented environments. Furthermore, based upon a look at the origins of demand that are identified, the reference models do not deal explicitly with customer order specific purchasing.

Directives that result from the foregoing can be summarized as follows:

1. Again, *the identified models can form the basis of any specification of a purchasing system*. They typically represent the core of any system that can be encountered at this moment, so in developing or selecting such a system they can be used very effectively and efficiently. They can also be used in identifying the data sets and relations between these data sets that are or are not present in the packages under consideration. The model of De Heij is even specifically aimed at this purpose. For the specific use of this type of model we therefore refer to his study (De Heij, 1996).

The foregoing conclusions and recommendations all follow from the answers to the first three research questions that were posed in the first chapter of this dissertation.

New IT Applications should support Initial Purchasing

Following the first conclusions, the next part of the research focused on the new directions in which supportive IT systems in purchasing should evolve. This part of the research primarily served as a means in focusing the then remaining research efforts.

The conclusion was that any new applications of IT in purchasing should be more supportive to so called initial purchasing decisions (i.e., sourcing and the relation of sourcing activities with outsourcing, product design and demand planning activities) in new task and modified rebuy situations, and the subsequent evaluation of the effectiveness thereof (i.e., performance measurement and assessment). As we found an increased presence of these last performance measurement systems in industry we subsequently focused on the application of IT in initial purchasing.

The characteristics of this application area further called for (1) analyses, evaluation and simulation tools; (2) flexible reporting and query capabilities; (3) communication functionality; (4) resource and process management tools; and (5) extended data and document management functionality. These requirements serve as the starting point for the next part of the research.

Directives that result from the foregoing can be summarized as follows:

1. Software vendors (and companies) that have implemented 'state of the art' purchasing functionalities, should now *focus their developments efforts on initial purchasing*. Other, less developed vendors and companies should focus their efforts on performance measurement and assessment.
2. In developing functionality for supporting initial purchasing and performance measurement, *use should be made of well-known generic IT tools* like data bases, simulation tools, communication software, project and workflow management systems, etc.
3. The foregoing directive, however, also implies that the focus in the application of IT in the industrial purchasing environment shifts from implementing ready-made, fairly 'mature' technology towards the *modeling (and possibly first re-engineering) of purchasing practices* (processes and data) in a way that generic IT tools can be applied.

Initial Purchasing — Purchasing and Purchasing Management

After the focus of the research was adjusted to comply with the conclusions summarized in the previous section, the research efforts were aimed at gaining a detailed insight in initial purchasing and answering the fourth (and partly seventh and eight) research question(s) on purchasing tasks, purchasing processes and their management.

The lessons that were learned through these efforts, were that initial purchasing tasks could be subdivided into purchasing and purchasing management tasks. Purchasing involves typical sourcing activities like the selection and contracting of suppliers (and the definition of the policies governing these decisions), as well as representing the supply perspective in the organization's outsourcing, product design and demand planning decisions. Purchasing management involves the establishment of purchasing policies, (multi-)project management, and operational workflow management.

Furthermore, the nature of purchasing as a process was discussed. The conclusion was that there are many different and successive events that can trigger purchasing processes, and that in practice many purchasing processes run simultaneously. It also showed that purchasing thereby tries to work in an 'anticipative' or 'pro-active' mode. In essence, this comes down to trying to provide case independent indications to the purchasing decisions that have to be made before a specific purchasing case needs to be handled. Examples hereof are (standard) contracts and the well-known Approved Suppliers Lists (ASL). The availability of these case independent documents speeds up the process significantly. Subsequently we therefore also made a difference between case independent and case dependent purchasing activities. However, it was also evident that it is not always possible to anticipate future cases and depending, for instance, on the novelty of the cases that need to be handled by purchasing.

Directives that result from the foregoing can be summarized as follows:

1. Purchasing managers may evaluate their current initial purchasing activities using the overview of core initial purchasing tasks including the establishment of sourcing policies, sourcing, the (constructive) evaluation of and contributions to outsourcing, product design and demand planning tasks, as well as purchasing management tasks.
2. Purchasing managers should be aware of the presence of multiple, time phased purchasing processes, all with different characteristics. This finding points out that it is important that *the purchasing manager of today has to possess highly developed managerial skills as well as tools*, in addition to knowledge and tools specifically related to the field.
3. In improving its performance or 'customer service', *purchasing professionals should focus their efforts as much as possible on case independent activities.* In this way cases can be handled both effectively and efficiently. Therefore purchasing managers should attempt to identify those cases where this is possible, and when not. In those cases where this is possible, forecasts enabling pro-active purchasing should be developed. These forecasts should cover the developments in the supply market (technologies, markets, products, and suppliers), active suppliers and their supply performance, end products and markets, internal customers, the organization, and the business environment (politics, economics, legislation, technology, ethics, environment, etc.). The remaining

capacity can then be directed towards those cases requiring specific attention.

Collecting Data is one of Initial Purchasing's Major Activities

After discussing purchasing tasks and processes the perceived differences in the way purchasing processes are carried out, as well as the reasons behind these differences were studied in order to answer the fifth research question on purchasing situations. The main lesson that was learned was that initial purchasing primarily aims at reducing the uncertainties and perceived accompanying risks of a particular situation through the collection of data and good decision making based upon these data. Initially, these uncertainties can pertain to demand and/or supply, and to issues relevant for costs, quality and/or delivery. The strategy in dealing with these uncertainties thereby depends not only on the source of the uncertainty (i.e., are efforts directed towards demand or supply, and do they address cost, quality or delivery issues?), but also on the consequences that are related to possible non compliance with specific requirements. Furthermore, the role of information and communication turned out to be essential as the collection of data is seen as the primary means in dealing with uncertainty.

Directives that result from the foregoing can be summarized as follows:

1. As purchasing aims at the cost effective satisfaction of customer requirements, purchasing professionals should *focus their efforts (and thus their investments in IT tools) on those situations and supply aspects that most severely affect the buying organization*. It should, however, only do this if results are expected that pay off, considering the required efforts. This requires an analysis of the purchasing portfolio, the perceived need for information in various situations, the frequency of occurrence of those situations, the potential benefits that may be expected form applying IT, and the required resources in implementing the required IT tools.
2. *Purchasing professionals should continuously assess their current support from communication and information technology* as these technologies are essential enablers of one of the primary activities in initial purchasing, i.e., the collection of data allowing effective decision making.

Implications for Information Technology

Although some general or purchasing related directives were already indicated in the previous sections, specific implications and design principles pertaining to the use of IT in the various initial purchasing tasks and situations are summarized below, providing an answer to the central research question:

1. In developing or selecting information systems supportive to (initial) purchasing, the required or desired *functionalities should be grouped (into toolkits for instance) according to managerial tasks and specific purchasing tasks* that need to be supported.
2. Purchasing systems that address purchasing management issues should be able to *accommodate data on processes (including (purchasing) projects and cases to be handled), resources, documents, operations and tools for use in purchasing tasks.*
3. As already was indicated, many generic tools are already available, especially for managerial tasks. Therefore, in supporting initial purchasing, *use should be made of existing tools, again also implying the need for modeling (and possibly first (re-)engineering) purchasing practices.*
4. Purchasing systems that address specific purchasing tasks should at least be able to *accommodate data on supply and its elements (sources, contractual relations, activities and products).*
5. Systems that are aimed at supporting initial purchasing, should *accommodate extensive supply models (involving data sets for organizational, process and product structures, operations, tools and equipment, location, and supply networks)* to meet the requirements of phenomena like suppliers as network partners, early supplier involvement in product development, and capability based decisions.
6. If possible (based upon the familiarity with the content of the case to be handled, as well as the approach to deal with the case), *systems should support purchasing by providing case independent reference data on the content of the case, and/or on the approach to deal with the case.* This implies that systems should allow the definition of these data on class level (e.g., aggregated data on the level of a product, activity or supplier type instead of on the level of a specific product, activity or supplier).

7. If a system should be able to accommodate a wide *diversity* of cases (resulting in a wide variety of, e.g., supplier profiles, assessment checklists, purchasing procedures, contracts, etc.), *use should be made of generic object models* as it allows many variants to be documented.
8. If a purchasing system needs to be adaptable to support processes that involve many initial uncertainties on how to handle the case (in terms of the content as well as the process), again, *use of generic object models is useful* as it enables flexible definition of additional features that might prove useful in the purchasing process. In this way, IT frees purchasing professionals of the 'stays' of current IT tools and allows the organization to become a learning organization.
9. In setting up an IT based environment to support purchasing, the architecture should *distinguish between a managerial layer, a purchasing specific layer, a document management interface layer, and a ubiquitous communication toolkit.*

After these initial design principles were defined, they were subsequently evaluated through the development of two prototypes. This allowed for the inclusion of detailed extensions and for the identification of issues related to the defined design principles. The conclusions and following directives resulting from these efforts are summarized next.

Lessons Learned — Source Selection

A need survey carried out in developing the prototype for source selection illustrated the importance of flexibility in any supportive tool. This pointed out the need for a tool that could support a wide variety of cases, and that accommodated an adaptable data base.

Important aspects of a supportive system that followed from a detailed analysis of various source selection cases can be summarized in the following directives:

1. A system supportive to source selection should be able to *monitor events that might trigger source selection processes*. This means that these systems should be able to track (1) supply performance, (2) purchasing efficiency and organizational conditions, (3) any new or changing needs, (4) market developments, and (5) the appropriateness of the supply base and contracts that are in place.

2. A minimal system supportive to source selection should at least *accommodate data sets for registering organizations and their capabilities* (activities and products).
3. To support more extensive selection techniques, IT tools supportive to initial purchasing should be able to *accommodate extensive supplier and supply network data* on various levels of abstraction. More specifically, these IT tools should allow the recording of data on aspects such as countries, organizational structures, processes, tools and equipment, and supply networks.
4. To be able to support the variety and dynamic nature of checklists that are often used in source selection processes, the already mentioned *generic functionality is required.*
5. In a system supportive to source selection, *a distinction should be made between data sets for documenting case independent sourcing policies and case dependent data on specific sources.*
6. Providing *access to data and documents (directly or through the use of instruments such as requests),* wherever residing, whatever format, is one of the most prominent requirements a system supportive to source selection should satisfy.
7. In supporting the managerial tasks of purchasing in source selection, *the concept of generic object models can be used in configurating and generating case specific procedures.*

The subsequent evaluation of the prototype showed that integration with and access to other systems, and data distribution were important aspects in actual implementation.

Furthermore, it was felt that the added value of the perceived system was in providing access to significant data in the source selection process, and the impetus that was expected from such a system on the consistency, structure and transparency of the process itself.

Lessons Learned — Contracting

In developing a prototype for contracting, it showed that contracting activities — like qualification activities — are closely integrated with the source selection process. Most of the contracting activities are aimed at the clarification of proposals during this process. Contracting activities further involve the formal definition of the agreements between supplier and buyer.

Another major conclusion was that documents play a very important role in the contracting process. A distinction can thereby be made between (state independent) standard contracts and (state dependent) specific contracts. Important aspect of these documents were related to the use of structured data elements or so called 'dotted line' elements, the fact that contracts are mostly of a similar structure, the fact that many of the texts are reused in different documents, the finding that documents (and their parts) have a life cycle of their own, and the fact that agreements are not only recorded in contracts but also in other correspondence with a supplier.

Most important design directives — focusing on the definition of contracts — that were derived from the discussion and analysis of contracting activities were:

1. Many of the aspects can again be addressed by adopting a generic approach. Therefore it is required to *restructure existing documents according to the concept of generic object models*, to define a generic document including its generic table of contents (GTOC), and to define various distinct variants of the document parts applicable to specific purchasing situations.
2. If contract documents are structured and documented as generic documents, *a system can be used for configuring and generating case specific contracts* without the direct involvement of legal specialists.
3. A system supportive to contracting should be able to *indicate the structured 'dotted line' elements* that still have to be specified in order to arrive at an actual contract, and to guide the user in this process.
4. A system supportive to contracting should provide support for *status, version, and copy control.*

In the evaluation of the prototype it was found that the possibility of accommodating contracting knowledge (and subsequently configuring specific contracts based upon this knowledge) was perceived as being the major advantage of the proposed system.

To fully capitalize on these benefits, however, considerable pre-implementation efforts were thought to be required in restructuring documents and processes, and in discovering and representing applicability rules. Furthermore, it was clear that the integration with systems, particularly those that accommodate the structured data used in the documents, would require additional attention.

SOFTWARE SELECTION AND DEVELOPMENT

The directives provided above can be used in selecting and developing systems supportive to initial purchasing. Therefore, we now briefly pay attention to software selection and development, and the role of the directives.

Phasing of Software Selection and Development Projects

There are many different ways in which software can be developed or selected. However, although there are some differences between these methods, the phasing of these methods hardly ever differs. In general, a software selection or development project goes through the following phases (see, e.g., NGI, 1992, pp. 8-13):

1. Set project objectives; organize and plan the project
2. Gear project to overall information plan
3. Model working concepts and methods in application domain
4. Deduce (functional, quality, performance, technical) requirements

If the organization — based upon the requirements and availability of software packages — decides to select a standard package, the phasing mostly continues as follows:

1. Draw up a 'long list' of software packages
2. Assess software packages through desk research and bid analysis
3. Draw up a 'short list' of software packages
4. Design a business case
5. Let software vendors demonstrate their solutions; visit reference customers
6. Select a software package; contract software vendor

If no suitable package is available, specific software development activities can be initiated, possibly phased as follows (see, e.g., Bemelmans, 1991, pp.246-250):

1. Model application domain in detail (processes, data)
2. Design technical system design (programs, procedures, data bases)
3. Build and test system

Although there are of course differences between the methods used for the selection and development of software there are some similarities as well. Especially with regard to the process and data modeling of the application domain and the subsequent establishment of functional specifications, many similarities exist. The level of detail in these specifications, however, does differ. Furthermore, in selection, the focus is on discriminatory factors, whereas a functional specification for a system that has to be developed should be complete.

Using the Directives in Selection and Development

As the focus in this study was on functionality, the resulting directives are particularly useful in the preparatory phase, when modeling processes and data, and when specifying functional requirements.

It should be noted, however, that with the current state of affairs, software selection probably will come down to selection of a suitable ERP/MRP package. This also implies that the design directives — as they focus on an area that is hardly represented in such packages — will not be of great use. The overview of existing packages and reference models provided in this study, however, can be useful.

The directives proposed in this study are primarily useful in:

1. the customization of standard packages after selection,
2. in the development of new functionalities in existing systems (see, e.g., Industry Snapshot 10-1), or
3. in the development of (completely) new systems.

In these cases the directives can be used as starting points for the modeling of processes, data and documents in initial purchasing, and thus for the following formulation of functional specifications and 'templates'. These 'templates' can be seen as the content of the generic object models (i.e., their parameters or features and possibly their related parameter values or options) allowing the definition of specific objects using these generic definitions.

INDUSTRY SNAPSHOT 10-1. Using the Directives in Enhancing *Baa*N's Distribution Module.

During the research, a project was carried out at *Baa*N Development aimed at the enhancement of the purchasing functionality in BaaN's Distribution module. After a detailed evaluation of the functionality provided by *Baa*N IV (the successor of Triton 3.1), enhancement actions were, a.o., aimed at providing users with (a) managerial support for handling requisitions and monitoring buyer workload, (b) flexible request functionality (on the document layer) in source selection processes, (c) interfaces to generic tools, (d) communication facilities, (e) feature-like functionality for describing suppliers, (f) accommodating item data on higher levels of abstraction (commodity groups), and (g) enhanced vendor rating possibilities.

REASONS TO INVEST IN INITIAL PURCHASING SYSTEMS

At this point, it is useful to consider the possible reasons to invest in the type of IT support proposed in this dissertation. Although not pertaining to one of the research questions, the (purchasing) managers working in the (industrial) practice are most certainly confronted with this investment issue over and over again. Therefore, this section will briefly discuss the arguments that may be used in underpinning the need for IT support in initial purchasing.

Investment arguments. Based upon Renkema (1996, p. 79) we distinguish between financial and non financial arguments and between positive and negative arguments (see Table 10-1). Furthermore, it should be noted that there is of course always a question of risk involved in deciding on investments, i.e., making investment decisions are always surrounded by a certain amount of uncertainty.

TABLE 10-1. Investment Arguments

Investment Arguments	*Positive*	*Negative*	*Total*
Financial	Yield	Costs	Profit or Loss
	Revenues	Expenses	Cash Flow
Non Financial	Positive Contribution	Negative Contribution	Contribution
Total	'Benefits'	'Costs'	'Value'

Source: adapted from Renkema, 1996, p. 79

Although the foregoing provides a framework for thinking about IT investments, in practice many (financial, but particularly non financial) arguments can be come across. Financial arguments are, e.g., discounted cash flow (net cash value), return on investment (ROI), and average profitability. Non financial arguments are countless and varied but primarily related to competitive position, business objectives (added value, market and customer orientation, or efficiency), end user needs or technology. Although mostly no 'formal' basis is available for these arguments, they do play a major role in decision making on IT investments.

Investment arguments for innovative IT in purchasing. In his book, Renkema provides a list of both financial and non financial consequences that may result from investments in IT for particular business processes (pp. 126-130). The non financial consequences are thereby grouped into consequences for the process, knowledge, strategy, decision making, structure and culture. Financial consequences are grouped into tangible benefits (efficiency improvements and increased revenues) and expenses (for realizing, using, and maintaining the application).

Most arguments for investing in innovative IT for purchasing in our study were found to be of a qualitative, non financial nature. Some issues, however, were raised that related to the more quantitative nature of financial investment arguments. The arguments and consequences of investments in innovative IT for purchasing discussed during our study are summarized below (see Table 10-2).[1]

TABLE 10-2. Consequences of an Investment in Innovative IT for Purchasing

Financial Consequences
1. Costs
1.1. Realization
Efforts required in properly integrating the innovative systems with currently available systems in different functional areas; possible pre-implementation efforts in modeling and (re-)engineering processes, decision making practices and documents; efforts required in deciding on the location/distribution of data
1.2. Organizational Change
Resistance to changing roles of specialists

[1] Of course, this is done without having the intention of being complete, as this was not the objective of the research.

1.3. Use and Maintenance

Data maintenance of rapidly changing data

2. Benefits

2.1. Efficiency

Reduction of clerical staff; efficient data maintenance; efficient data accessibility

2.2. Effectiveness/Revenues

Reduction of purchasing risks due to improved and more effective decision making and reduction of uncertainties (these risks may relate to (future) supply bottlenecks, bankruptcy, etc.); improved customer satisfaction because of improved quality, shorter time-to-market (TTM), faster response, etc.; cost reductions through improved purchasing coordination and decision making

Non Financial Consequences

1. Process

Availability of knowledge for non specialists; flexibility and adaptability of the way of working; increased consistency, transparency and structure of the process; improved purchasing coordination

2. Knowledge

3. Strategy

To enable purchasing (management) to respond to its complex and volatile business environment; contribution to overall business objectives by capturing upstream benefits of Early Purchasing Involvement and significant cost reductions

4. Decision Making

To maintain (or even increase) the performance level of purchasing as a result of the timely availability of relevant, actual, accurate, consistent and reliable data for use in decision making, contract negotiations, and management; accessibility to required data; search power during market research; elimination of ad hoc and inferior decision making; opportunities for purposive analysis

5. Structure

Decentralization effects due to the fact that knowledge can be recorded and made available to other functionaries in the organization

6. Culture

Opportunities for delegated responsibilities as knowledge can be made available to lower hierarchical levels mostly resulting in shifting responsibilities; interdisciplinary work force making use of the available knowledge of various disciplines; purchasing practices are transparent which implies an increased attention for justification and accountability of purchasing decisions and performance and supplier performance

From Table 10-2 it shows that the systems based upon the design principles proposed in this study were mainly perceived as being beneficial to the effectiveness of purchasing decision making. It is also believed that effective decision making in initial purchasing yields bottom line results in terms of reduced risks, increased customer satisfaction and reduced costs. Efficiency was not heavily stressed during the discussions on costs and benefits.

Reflections on the mutual relation between IT and the organization. From Table 10-2 it is also clear that the impact of these type of systems on the organizational division of labor, authorities, responsibilities, structure and culture cannot be underestimated.

The possibility of distributing (explicit) knowledge may have an effect on the location where work may take place, and by whom this work may be carried out. It stimulates and enables decentralization and delegation of responsibilities without losing control over decision making quality and consistency. The knowledge made available to lower hierarchical levels can be seen as the glue that holds together increasingly flatter organizational structures. Furthermore, the communication tools currently available add to the short circuiting of hierarchical structures, and the enabling of dynamic operational working relations. The above also implies that the role of experts may change. Instead of being heavily involved in operational projects, they might focus their efforts on developing and improving the knowledge required in the operations. Thus, IT might very well change the role of the purchasing department within an organization from an executive role towards a more conditioning role.

Furthermore, the proposed design directives also enable dynamic organizational learning, as new knowledge may be incorporated into the systems 'on the spot'. They therefore allow flexible and adaptable working methods in purchasing that are required in the current volatile business environment.

The evaluations of the design directives also indicate the impetus that is provided by the perceived systems for the transparency of the purchasing decisions and processes. This allows purchasing professionals to better justify their decisions and practices, to take up their accountability and to cope with the increasing attention of top management.

However, although the application of innovative IT tools in purchasing may stimulate and enable new organizational structures and working patterns, the organizational culture is an extremely important aspect in this relation. The organizational culture may stimulate and enable the (early) adoption op such innovative tools, or it may stand in its way. The norms and values of the organization reflected in its style of leadership, HRM policies, the type of personnel (reflected in their age, education, etc.) and other elements of organizational culture therefore cannot be seen independently of the success of any innovative IT application.

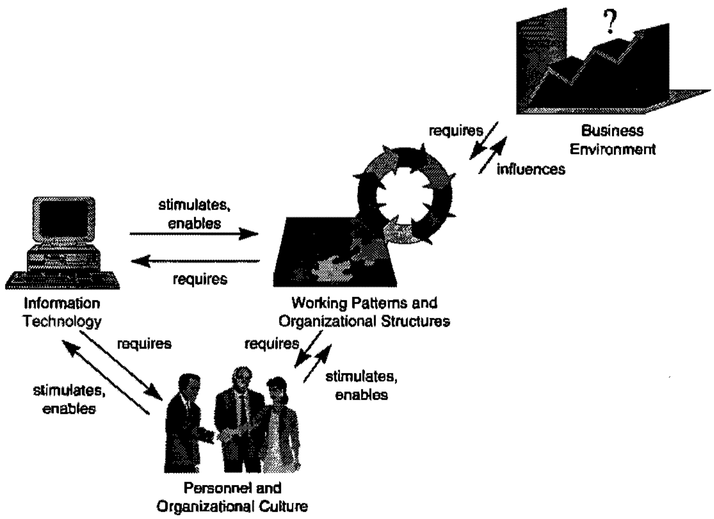

FIGURE 10-1. Perceived relations between IT and organization.

CONTRIBUTIONS TO ADVANCEMENT IN THE FIELD

In addition to the conclusions and corresponding directives related to the application of IT in purchasing, this research has also produced some valuable insights for the fields of purchasing and information technology independently.

Contributions to the Field of Purchasing

Purchasing Tasks and Performance. A first contribution to the field of purchasing is related to the structure and definition of the purchasing function. During this study it was shown that it is useful to distinguish between purchasing management, purchasing, and supply. Supply performance (and its alignment with company objectives) thereby is the ultimate responsibility of purchasing, governed by purchasing management. It also indicates the relevance of distinguishing between supply performance, and the (derived) purchasing and purchasing management performance.

Purchasing Process. A second contribution concerns the enhancement of the presently available process models of purchasing. Current models mostly ignore (perhaps intentionally) the fact that in reality isolated purchasing processes hardly ever occur. The study has shown that in reality many purchasing processes may occur shifted in time, and that these processes are carried out simultaneously. Furthermore, the study showed that purchasing processes are not always carried out in their entirety, depending upon the case. The enhanced process models of purchasing may support purchasing professionals in organizing and managing their operations.

Purchasing Typologies. Part of this study also discussed some of the typologies that are in use in purchasing. Together with a detailed case study that was carried out, our study showed that most of the characteristics used in these typologies were indeed important in understanding and improving purchasing practices. Additional insight was gained through focusing on the reasons behind practices, resulting in knowledge that may support purchasing managers in developing strategies and focusing their efforts. Furthermore, the role of performance management and Total Cost models was positioned in a broader context.

Sourcing. The detailed case studies also produced detailed and valuable insights in the way sourcing processes are carried out. These insight may prove useful in (re-)organizing and managing these important processes. Furthermore, the roles of selection, qualification, and contracting were put in perspective by integrating them into one sourcing process.

Contributions to the Field of Information Technology

Tool Improvements. Valuable insights have been gained through the evaluation and application of IT based tools in the purchasing environment. The research showed that although many tools are not specifically developed for a particular domain, the application of such tools may yield insights that may be useful in improving these tools (e.g., the requirement of generating suitable workflows depending upon case characteristics in a Workflow Management System).

Importance of Generic Tools and Domain Knowledge. Although most efforts often are aimed at developing specific tools for a particular domain, this study demonstrated the benefits that can be gained from using generic tools. This, however, also implies, that the emphasis in realizing these benefits should shift towards modeling domain specific knowledge for use in these generic tools.

Integration, Communication, and External Data. Although we demonstrated the potential benefits from generic tools, it also showed that if there are no integration possibilities, these potential benefits will not be realized. This study further showed the importance of communication facilities in any present system. Especially in present day decision making, most of the data on which decisions are based are not available internally. Therefore, providing communication tools as well as access to external data is a requirement that modern systems should satisfy.

The Power of Generic Object Models. This study clearly demonstrated the power of generic object models. It was demonstrated that this concept can be applied in configuring and generating process descriptions (workflows), documents, etc. depending upon case characteristics. Again, however, this implies that domain specific knowledge should be made explicit and possibly restructured enabling the use of this concept.

The Results in Perspective

An interesting question form a scientific point of view, but certainly also for practitioners working in other companies and other economic sectors than those companies involved in this research, is the question to what extent the conclusions, and design principles and directives presented in this study can be generalized and used in comparable situations. Several arguments support the proposition that this is possible to a large extent. These are:

- *Choice of Cases.* Although it is obvious to suppose that the individual companies participating in this study are the cases based upon which the conclusions and directives were derived, this is *not* the case. The cases in this study pertain to the cases that needed to be handled by purchasing. Many of these case types are also present in other companies and in other economic sectors.

- *Choice of Case Characteristics.* The developed case characteristics that were assumed relevant for the way in which purchasing operates, are all of a nature that surpasses individual companies and economic sectors. Differences across companies and economic sectors will occur only in the way in which the developed characteristics are perceived.

These first two arguments are based upon the notion of 'analytic generalization' proposed by Yin (1989, pp. 21, 44). His theory poses that the conclusions and directives can generalized into theory, and subsequently applied in those cases that have many characteristics in common with the cases underlying the theory. Furthermore, as Kennedy states (1979, p. 672), "the evaluator should produce and share the information, but the receivers of the information must determine whether it applies to their own situation. Because of the evaluator cannot know who his receivers are, he must, of course, be quite specific in his description of the attributes of his case". Therefore, in addition to the considerations mentioned above, we provided many fairly detailed and extensive case descriptions in our study.

Another argument supporting our proposition is the fact that during our study, three workshops were organized involving experts from various industrial companies, consultants, and IT experts. Although many remarks were made during these workshops (and — if considered an improvement — taken into account in further research activities), not many concerned the conclusions, principles and directives that were developed. Most of the remarks concerned aspects that did not directly pertain to the scope of this particular study, but provided 'food for thought' related to the implementation of the directives, mostly from an organizational or technical perspective.

RECOMMENDATIONS FOR FURTHER RESEARCH

The use of information technology in industrial purchasing was the central theme of this dissertation. The objective was to increase the knowledge about current professional IT applications in industrial purchasing, but also about possible new and more effective applications. We are, however, aware that this study is only one out of many contributions to this field of knowledge. Therefore, many issues are still open to discussion and need to be tested in practice, and many issues have not been part of our scope of research. This section therefore summarizes some issues for future research thus forming a research agenda based upon the results from this study.

Research in the Field of Purchasing

Inter-organizational Concurrent Engineering. Although we have indicated that purchasing's primary initial task is related to sourcing, it was also shown that there is a close interaction with the product design task. Purchasing's role thereby in essence consisted of evaluating design proposals on their consequences for supply, and of contributing to the design by providing supply market knowledge. In addition, we have indicated that suppliers become increasingly early involved in the product development process. Purchasing's specific tasks in these situations, as well as the role of suppliers in product development (inter-organizational concurrent engineering) are important and relatively new topics that require further attention.

Organizing and Managing Purchasing Processes. This study revealed some interesting concepts for structuring purchasing processes. The intention hereof, however, was to gain insight in how to support these processes by IT. These insights might, however, also be used in (re-) organizing or re-engineering purchasing processes and their management aimed at performance improvement. How this exactly can be done and what possible results might be, can be an interesting issue to research.

Research in the Field of Purchasing and Information Technology

Cost-Benefit Evaluation. Although we have focused on the functionality required to support purchasing professionals in their jobs, no thorough evaluation of costs and benefits of such systems has been provided. Additional research is, however, required although much general knowledge is available about the evaluation of IT investment proposals (see, e.g., Renkema, 1996).

Internet. One of the most interesting developments of the last few years has been the appearance of the Internet and the World Wide Web (WWW). Many interesting developments take place 'on the Internet' that directly influence market transparency and structures, as well as the way transactions are carried out. Although many researchers have already turned their attention to this phenomenon, it might prove fruitful to pay attention to the specific implications and possibilities of the Internet from a purchasing perspective.

Distributed Systems. Another major finding frequently encountered during our research, but not within the scope of our research, was the need for distributed systems. Especially in large organizations, the exploitation of purchasing leverage is extremely important. Furthermore, as many disciplines are involved in the purchasing process, access to cross functional data is an important issue in supporting the process. Lastly, as much data is available externally, issues pertaining to data ownership or content responsibility, the role of suppliers, branch organizations and central agencies (or even new specialized content providers), and so on appear on the scene.

Purchasing Card. Another fairly recent development has been the appearance of the purchasing card in purchasing operations. Although the technology is fairly straightforward, not many organizations are yet acquainted with the application and implications of the card. The implementation of the purchasing card therefore might prove to be an interesting issue to study. Furthermore, as credit card organizations also offer value added services in the field of management information, it is interesting to study how these services can be integrated with internal systems.

Research in the Field of Information Technology

Application of Generic Object Models. Following our findings that the concept of generic object models appears to be an extremely powerful concept to implement any object in a generic way, it is recommendable to further study this. In particular in the area of workflow management it may significantly extend the application possibilities of current WfM systems. Furthermore, it is desirable to study the usefulness of object oriented (OO) technology to implement the concept. As inheritance of characteristics that are relevant for configuration through the object structure is an important aspect of the use of the concept, OO technology (supporting inheritance) may prove to be very useful.

Knowledge Representation. We have indicated that if generic tools are to be used, the attention should shift towards making domain knowledge explicit in a way that is suitable for these generic tools. Although the generic functionalities are of course important, this knowledge representation (and the subsequent management of this knowledge) may turn out to be the most valuable asset to a company.

Integration. Another issue pertaining to the use of the concept of generic object models, involves the integration of systems based upon generic object models with systems that are not. We already indicated that the features in the concept of generic object models are implemented as entities whereas these features in 'traditional' systems are implemented as attribute types. This difference in the level of abstraction poses integration problems between these tow type of systems, requiring further research.

Document Interface. Although conceptually indicated as being an interface layer between a managerial layer and a layer with domain specific tools, the exact implications and implementation thereof requires additional research. Traditional systems implement 'hardwired' documents, whereas the proposed approach only allots a managerial role to documents, providing a view on structured, domain specific data. Issues that have to be dealt with in this approach are comparable to those mentioned when discussing the previous point of integration.

EPILOG

At the outset of this study, the objective was defined as to increase the knowledge about current professional IT applications in industrial purchasing, but also about possible new and more effective applications. We hope that we have succeeded in achieving our objective and that the results reported in this study to will enable the improvement of the profession of industrial purchasing as a whole.

Throughout the study, it showed that — like in industry — the importance of a well-considered (research) plan cannot be overestimated. The attention that was paid to define the initial research has certainly paid off during the research. Furthermore, this research has demonstrated the usefulness of adopting a professional and design oriented approach to doing research, as well as involving (industrial) companies in business related academic research. There are, however, some remarks that can be made to further improve the way in which this type of research can be performed.

First, the initial research objectives in this type of research should preferably be supported by a platform of supposingly 'leading edge' organizations in the relevant field to guarantee the originality of the research. Business related academic research should beware not to focus on generating marginal knowledge that does not contribute significantly to the advancement in the field. This, however, does not imply that usefulness is not a relevant criterion in evaluating research proposals, however, only if significant advancements to the field as a whole are implied. This also implies that a thorough study of the field and evaluation of the initial research proposal should always precede any final research design (or such an activity should be incorporated explicitly in the research design). Research in this area is sometimes tempted by research questions posed by only a small set of potential user organizations, without questioning the overall value of the potentially resulting knowledge.

Second, adopting a professional approach to research does not imply that creativity is constrained. Neither does it imply a bureaucratic, strictly organized research factory. It does, however imply a multidisciplinary approach to research, with ample time and opportunities to meet and to discuss issues that arise, information sharing, open communication, etc. Taking this as well as proven industrial practices that are applied in new product development into account, it is advisable to award doctorates based upon research not only carried out in a team, but also reported as a team. After all, we should not forget that research is not only a means in getting a degree, but in essence is all about gaining knowledge ... .

References

Andriesse, F. (1992) 'Philips-topman Ruts: Co-makership is geen panacee"' (Eng: Philips' top official Ruts: "Co-makership is no panacea") Tijdschrift voor Inkoop & Logistiek, Vol. 8, No. 6.

Ansari, A. and Modarress, B. (1988) 'JIT Purchasing as a Quality and Productivity Centre' *International Journal of Production Research*, Vol. 26, Iss. 1, pp. 19-26.

Asker, J.R. (1994) 'NASA solicits bids via Internet' *Aviation Week & Space Technology*, October 17, p. 58.

Baily, P. (1987) *Purchasing and Supply Management*, London: Chapman & Hall.

Baily, P. and Farmer, D. (1985) *Purchasing: Principles & Management*, London: Pitman Publishing.

Baily, P. and Farmer, D. (1990) *Purchasing: Principles & Management*, London: Pitman Publishing.

Bank Marketing (1994) 'Purchasing Cards Help America Do Business' *Bank Marketing*, September, p. 7.

Barreyre, (1988) 'The Concept of Impartition Policies: A Different Approach to Vertical Integration Strategies' *Strategic Management Journal*, Vol. 9, No. 5 (September-October), pp. 507-520.

Belonje, C.J. (1995) *Een Total Cost of Ownership model voor Finished Products bij Philips* (Eng: A Total Cost of Ownership model for Finished Products at Philips), Eindhoven: Eindhoven University of Technology (Master thesis, based upon a project carried out at Philips Corporate Purchasing).

Bemelmans, T.M.A. (1991) *Bestuurlijke informatiesystemen en automatisering* (Eng: Administrative information systems and automation), Deventer: Kluwer Bedrijfswetenschappen/Stenfert Kroese.

Bender, P.S., Brown, R.W., Isaac, M.H. and Shapiro, J.E. (1985) 'Improving Purchasing Productivity at IBM with a Normative Decision Support System' *Interfaces*, Vol. 15, No. 3 (May-June), pp. 106-115.

Berenschot and Logiplan (1994) *Softwarepakketten voor produktiebesturing & elektronische planborden* (Eng: Software for production control & electronic planning), Utrecht/Badhoevedorp: Berenschot/Logiplan.

Berlet, H. (1974) 'Volatile business world makes MIS invaluable decision making tool' *Data Communication User*, December, pp. 50-52.

Bertrand, J.W.M., Wortmann, J.C. and Wijngaard, J. (1990) *Production Control: A Structural and Design oriented Approach*, Amsterdam: Elsevier.

Birmingham, D.J. (1972) 'Factory data systems smooth production flow' *Computer Decisions*, Vol. 4, No. 3, March, pp. 8-13.

Blumberg, F. (1991) *Wissenbasierte Systeme in Produktionsplanung und -steurung: Implementierungs- und Integrationsaspekte, dargestellt an einem Beispiel aus dem Beschaffungsbereich* (Eng: Knowledge-based Systems in Production Planning and Control: Implementation and Integration Aspects represented by an Example in the Field of Purchasing) Hohenheim: Hohenheim University, pp. 136-249.

Boer, L. de and Stekelenborg, R.H.A. van (1996), 'Decision support for contemporary purchasing' in Cox, A. (ed.) Innovations in Procurement Management (Proceedings of the 4th International Annual IPSERA Conference, Birmingham, UK, April 1995), Boston: Earlsgate Press, pp. 173-192.

Bosch M. and Heijen, J.W.J. (1995) *Informatie: en must voor portfoliomanagement: Via portfoliomanagement binnen AT&T Network Systems Nederland B.V. naar een vergrote toegevoegde waarde van de afdeling Corporate Procurement* (Eng: Information: a must for portfolio management), Hilversum: AT&T Network Systems Nederland B.V.

Botter, C.H., Boer, H. and Fisscher, O.A.M. (1994) *Industrie en organisatie* (Eng: Industry and organization), Deventer: Kluwer Bedrijfswetenschappen, pp. 343.

Boyd, R.C. and Brown, J.J. (1975) 'Penn Central's 'MAP' speeds data gathering on inventory, costs, shipments', *Data Communications*, Vol. 4, No. 4, July-August, pp. 40-44.

Brandel, W. (1995) 'A faster way to buy' *Computerworld*, May 8, p. 41.

Breuls, P. (1996) 'Enterprise Document Management', *Proceedings ASI '96 Conference*, Toulouse, June.

Bunn, M.D. (1993) 'Taxanomy of Buying Decision Approaches' *Journal of Marketing*, January.

Bunn, M.D. and Clopton, S.W. (1993) 'Patterns of Information Source Use Acroos Industrial Purchase Situations' Decision Sciences, Vol. 24, No. 2.

Burt, D.N. (1991) 'Strategic Pricing Aims at All-In-Cost' *Purchasing World*, March.

Buter, J.I.H. (1990) 'Automatisering, ook in inkoop?' (Eng: 'Automation, also in purchasing?') *Tijdschrift voor Inkoop & Logistiek*, Vol. 6, No. 3, pp. 28-33.

Campbell, N.G.C. (1985) 'An interaction approach to organizational buying behaviour' *Journal of Business Research*, 13, pp. 35-48.

Cantor, J. and Loda, F. (1967) *Mechanized Purchasing Systems*, Bulletin No. 104, New York: American Management Association.

Carr L. and Ittner, C. (1992) 'Measuring the Cot of Ownership' *Journal of Cost Management*, Fall, p. 42-51.

Carter, J.R. and Ragatz, G.L. (1991) 'Supplier Bar Codes: Closing The EDI Loop' *International Journal of Purchasing and Materials Management*, Vol. 25, Summer, pp. 19-23.

Cavinato, J.L. (1991) 'Evolving procurement organisations: logistic implications' *Journal of Business Logistics*, Vol. 13, Iss. 1.

CBS (Dutch Central Office of Statistics) (1991) *Statistisch Bulletin*, No. 30, July 18.

Child, J. (1987) 'Information Technology, Organization, and the Response to Strategic Challenges' *California Management Review*, Vol. 30, Iss. 1 (Fall) pp. 33-50.

Claessen, P.A.M. (1988) *Inkoop management informatie: Van verwervingsinformatie naar informatieverwerving* (Eng: Purchasing management information: from procurement information towards information procurement), Eindhoven: Eindhoven University of Technology (Master thesis, based upon a project carried out at AT&T and Philips Telecommunications).

Cleetus, J. (1992) *Definition of Concurrent Engineering*, CERC Technical Report CERC-TR-RN-92-003, West Virginia University: Concurrent Engineering Research Center.

Clemens, M.W. and Smytka, D.L. (1993) 'Total Cost Supplier Selection Model: A Case Study' *International Journal of Purchasing and Materials Management*, Winter.

Coad, P. and Yourdon, E. (1991) *Object-Oriented Analysis*, Englewood Cliffs: Prentice-Hall.

Cone, R.J. (1978) 'Purchasing in the New Computer Environment', *Journal of Purchasing and Materials Management*, Vol. 14, Summer, pp. 2-4.

Cook, R.L. (1992), 'Expert Systems in Purchasing: Applications and Development' *International Journal of Purchasing and Materials Management*, Vol. 26, Fall, pp. 20-27.

Cousins, P.D. (1992) 'Purchasing, The professional approach' *Purchasing and Supply Management*, September.

Croom-Morgan, S. and Wilson K. (1993) 'Inter-Organisational Relationships: Understanding the Process of Industrial Buying Behaviour' In: Lamming, R. and Cousings, P. (eds.) *Proceedings of the 2th International Annual PSERG (IPSERA) Conference*, Bath, UK, April 1993.

Data Communications User (1974) 'Datacomm frees buyer to find new supplies - and at best price', *Data Communications User*, Vol. 3, No. 1, January, pp. 67-68.

Davis, G.B. (1982) 'Strategies for Information Requirements Determination' *IBM Systems Journal*, Vol. 21, No. 1 pp. 4-30.

Davis, P.S. and Tasso, T.L. (1969) 'EDP and Purchasing in Northern California' *Journal of Purchasing*, Vol. 5, August, pp. 32-40.

Day, J. 'Procurement Cards Pack Power by Collecting Valuable POS Data' *Bank Systems + Technology*, 1994, pp. 22-23.

Donselaar, K.H. (1989) *Material Coordination under Uncertainty*, Eindhoven: Eindhoven University of Technology.

Dubois, A., Gadde, L.-E. and Håkansson, H. (1989) *The Impact of Information Technology on Purchasing Behaviour and Supplier Markets — A Prestudy*, Working Paper No. 1989:11, Göteborg: Chalmers University of Technology, Institute for Management of Innovation and Technology, p. 56.

Eck, A. van, (1989) 'Inkoopautomatisering: ervaringen uit een adviespraktijk' (Eng: 'Purchasing automation: experiences from consultancy') *Tijdschrift voor Inkoop & Logistiek*, Vol. 5, No. 10, pp. 26-33.

Edmondson, G. (1996) 'Silicon Continent: Surprise! Europe is finally getting its software act together—and going after America's lead' *Busines Week*, May 6, pp. 34-38.

Eldin, H.K. (1983) 'Acquisition Management Information System (AMIS)' *National Contract Management Journal*, Vol. 16, No. 2 (Winter), pp. 53-60.

Ellis, C.A., Gibbs, S.J., Rein, G.L. (1991) 'Groupware: Some Issues and Experiences' *Communications of the ACM*, Vol. 34, No. 1 (January), pp. 38-58.

Ellram, L., (1993a) 'Total Cost of Ownership: Elements and Implementation' *International Journal of Purchasing and Materials Management*, Fall.

Ellram, L. and Perrott Siferd, S. (1993b) 'Purchasing: The Cornerstone of The Total Cost of Ownership Concept' *Journal of Business Logistics*, Vol. 14, No. 1.

Erens, F.J. (1996) *The Synthesis of Variety: Developing Product Families*, Eindhoven: Eindhoven University of Technology/KPMG Management Consulting.

Erens, F.J. and Stekelenborg, R.H.A. van (1993) 'DFP: Design for Purchasing! Ondersteuning van inkoop bij simultaneous engineering' *Verkorting van doorlooptijd: congresbijdragen CAPE'93*, Alphen aan den Rijn: Samsom BedrijfsInformatie, pp. 37-53.

Faes, Ch. (1986) 'Introductie van personal computer op inkoopafdeling' (Eng: 'Introduction of a personal computer to the purchasing department') *Tijdschrift voor Inkoop & Logistiek*, Vol. 2, No. 5, pp. 16-19.

Fearon, H.E., Dobler, D.W. and Killen, K.H. (eds.) (1993) *The purchasing handbook* (5th ed.), London: McGraw-Hill

Fogg, M. (1994) *The 1994/1995 Software Survey: A report on the survey and its findings*, CIPS.

Ford, D. (1980) 'The Development of Buyer-Seller Relationships in Industrial Markets' *European Journal of Marketing*, Vol. 14, No. 5/6.

France, M. (1994) 'Smart Contracts' *Forbes ASAP*, Aug 29, 1994, pp. 117-118.

Freeman, V.T. and Cavinato, J.L. (1990) 'Fitting Purchasing to the Strategic Firm: Frameworks, Processes, and Values' *Journal of Purchasing & Materials Management*, Vol. 26, Iss. 1 (Winter), pp. 6-10.

Galbraith, J. (1973) *Designing complex organizations*, London: Addison-Wesley.

Greveling, N.J.W. (1990) *Informatieplanstudie: model voor strategie* (Eng: Information planning: a model for strategy), Schoonhoven: Academic Service.

Haeckel S.H. and Nolan R.L. (1993) 'Managing by Wire' *Harvard Business Review*, September-October, pp. 122-132.

Håkansson, H. (1982) *Industrial Marketing and Purchasing of Industrial Goods*, New York: John Wiley & Sons.

Hall, R.W. and Vollmann, T.E. (1978) 'Planning your materials requirements', *Harvard Business Review*, Vol. 56, No. 5, September-October, pp. 105-112.

Hammer, M. and Champy, J. (1993) *Reengineering the corporation: a manifesto for business revolution*, London: Nicholas Brealey.

Handley, C. (1988) 'Pulling the mainframe plug' *Purchasing*, May 26, pp. 56-60.

Harris, B.J. and Rulis, L.A. (1976) 'Materials information system', *Journal of Systems Management*, Vol. 27, No. 6, June, pp. 20-23.

Hay, E.J. (1988) *The Just-in-Time Breakthrough: Implementing the New Manufacturing Basics*, New York: John Wiley & Sons.

Heer, M.C. de (ed.) (1994) *Workflow Management Systemen op een rij*, Utrecht: Moret Ernst & Young Management Consultants

Hegge, H.M.H. (1995) *Intelligent Product Family Descriptions for Business Applications: Production Control Software based upon Generic Bills-of-Materials in an Assemble-to-Order/Make-to-Stock Environment*, Eindhoven: Eindhoven University of Technology.

Heij, J.C.J. de (1994) 'The use of data models for assessing standard logistics software' *Computers in Industry*, Vol. 25, No. 2 (December), pp. 211-216.

Heij, J.C.J. de (1996) *Assessment of Business Information Systems by Data Structures*, Deventer: Kluwer Bedrijfsinformatie, pp. 122-161.

Heij, J.C.J. de, and Stekelenborg, R.H.A. van (1994) 'An assessment of information systems for purchasing based on data models' *Revolution in Purchasing: From Spending to Strategy*, Proceedings of the 3rd Annual International IPSERA Conference (28-30 March), Cardiff: University of Glamorgan Business School, pp. 157-170.

Heinritz, S., Farrel, P.V. and Giunipero, L.C. (1986) *Purchasing: Principles and Applications*, Englewood Cliffs: Prentice Hall.

Hetzel, F. and Köster, W. (1971) *Datenverarbeitung mit System*, Darmstadt: Luchterhand Verlag GmbH.

Hirschman, A.O., (1970) *Exit, Voice and Loyalty: Responses to Decline in Firms, Organizations and States*, Cambridge, Mass.: Harvard University Press.

Hoekstra. Sj. and Romme, J.H.J.M. (1993) *Towards Integral Logistics Structures - Developing Customer Oriented Goods Flows*, New York: McGraw-Hill.

Hofman, W.J. (1994) *A conceptual model of a Business Transaction Management System* Amsterdam: Tutein Nolthenius.

Huber, R.F. (1979) 'Computerized parts tracking slashes inventory costs', *Production*, Vol. 84, No. 2, August, pp. 94-96.

In't Veld, J. (1988) *Analyse van organisatieproblemen: een toepassing van denken in systemen en processen* (Eng: Analysis of organizational problems: an application of thinking in systems and processes) (5th ed.), Leiden: Stenfert-Kroese.

Information Today (1995) 'First Data Brings Secure Payment Processing to the Internet with Netscape' *Information Today*, February, p. 34.

Janson, R.L. (1989) 'Least Total Cost Purchasing' *Purchasing World*, April.

Katzel, J. (1976) 'The do-it-yourself information retrieval system', *Folio*, Vol. 5, No. 1, February, pp. 48-50.

Kennedy, M.M. (1979) 'Generalizing from single case studies', *Evaluation Quarterly*, Vol. 3, No. 4, pp. 661-678.

Kollios, A.K. and Stempel, J. (1966) *Purchasing and EDP*, New York: American Management Association.

Kolodziej, S. (1994) 'Lockheed cures the procurement blues' *Network World*, November 7, p. 55.

Kornelius, L., Kreuwels, C.M.A. and Vlist, P. van der (1992) 'Aspects of the External Integration of Production Management Systems with EDI' in Pels, H.J. and Wortmann, J.C. (eds) *Integration in Production Management Systems* (Proceedings of the IFIP WG 5.7 Working Conference, Eindhoven, The Netherlands, August, 1992), Amsterdam: Elsevier Science Publishers, pp. 175-182.

Kraljic, P. (1983) 'Purchasing Must Become Supply Management' *Harvard Business Review*, Vol. 61, Iss. 5 (September-October), pp. 109-117.

Kreuwels, C.M.A. (1994) *Externe logistieke integratie en EDI: naar meerniveau-afstemming tussen toeleverancier en afnemer* (Eng: External logistic integration: toward multi-level co-ordination between supplier and buyer) Deventer: Kluwer Techniek, pp. 237.

La Londe, B.J. and Emmelhainz, M.A. (1985) 'Electronic Purchase Order Interchange' *Journal of Purchasing and Materials Management,* Vol. 21, pp. 1-6.

Lamming, R. (1993) *Beyond Partnership: Strategies for Innovation and Lean Supply,* London: Prenctice-Hall.

Leenders, M.R. and Flynn, A.E. (1995) *Value-Driven Purchasing: Managing the Key Steps in the Acquisition Process,* New York: Irwin.

Lester, A. and Benning, A. (1989) *Procurement in the Process Industry,* London: Butterworths & Co.

Leeuw, A.C.J. de (1993) *Een boekje over bedrijfskundige methodologie: management van onderzoek* (Eng: A book on methodology for business administration: management of research), Assen: Van Gorcum.

Lierop, F. van, Vanmaele, H. and Hermans, R. (1996) 'Vraag en aanbod op de ERP-markt geïnventariseerd' (Eng: A survey of demand and supply on the ERP-market), *Tijdschrift voor Inkoop & Logistiek,* Vol. 12, No. 4 (April), pp. 14-18.

Lindgren, D.A. (1968) *The Use of Electronic Data Processing in Industrial Purchasing Departments of Large United States Corporations,* unpublished doctoral dissertation, Madison: University of Wisconsin.

Lyons, P.E. (1989) 'Shaving Inventory and Growing Responsive with JIT' *Quality Progress,* June, pp. 52-53.

Lyons, P.J. (1979) 'Better Purchasing Through Information System Maintenance', *Journal of Purchasing and Materials Management,* Vol. 15, Winter, pp. 16-19.

Malley, J.C. and Ray, R. (1988) 'Informational and organizational impacts of implementing a JIT system' *Production and Inventory Management Journal,* 2nd quarter, pp. 66-70.

Martin, J. and Odell, J.J. (1994) *Object-Orieneted Analysis and Design,* Englewood Cliffs: Prentice-Hall.

McQuiston, D.H. (1989) 'Novelty, Complexity, and Importance as Causal Determinants of Industrial Buying Behavior', *Journal of Marketing,* 53 (April), pp. 66-79.

Minkema, D.G., (1992) *Informatiesystemen voor inkoop: van orderbeheer naar beslissingsondersteuning* (Eng: 'Information systems for purchasing: from order administration towards decision support'), Rotterdam: Coopers & Lybrand Management Consultants, pp. 17.

Modern Materials Handling (1983) 'Software speeds the flow at the receiving dock', *Modern Materials Handling,* March, pp. 76-78.

Monczka, R.M. and Carter J.R. (1987) *Electronic Data Interchange: Managing Implementation in a Purchasing Environment,* East Lansing, Michigan: Computer

Information Systems and Technology Group, National Association of Purchasing Management, pp. 92.

Moore, D.L. and Fearon, H.E. (1973a) 'Computer Operating and Management-Reporting Systems in Purchasing', *Journal of Purchasing*, Vol. 9, August, pp. 13-39.

Moore, D.L. and Fearon, H.E. (1973b) 'Computer-Assisted Decision-Making in Purchasing', *Journal of Purchasing*, Vol. 9, November, pp. 2-25.

Moore, D.L. and Fearon, H.E. (1974) 'Why Haven't Computers Been Used More Effectively in Purchasing?', *Journal of Purchasing*, Vol. 10, August, pp. 30-39.

Moran, J.P. (1979) 'Data system improves material management', *Industrial Engineering*, Vol. 11, No. 10, October, pp. 41-42.

Nessim, H. (1975) '10 ways inflation recession challenge marketers with pricing responsibilities', *Marketing News*, Vol. 8, No. 16, February 28, pp. 4-5.

Nijs, W. (1991) *Grondslagen van de inkoop: Een eigentijdse benadering* (Eng: The bases of purchasing: A contemporary approach), Deventer: Kluwer Bedrijfswetenschappen.

Nijssen, J.G., (1986) 'Het ontwerpen van een inkoopsysteem' (Eng: 'The design of a purchasing system') *Tijdschrift voor Inkoop & Logistiek*, Vol. 2, No. 5, pp. 43-45.

NGI (1992) *Ervaringen met pakketten: ervaringen van gebruikers van logistieke pakketten* (Eng: Experiences with packages: experiences of users of logistics packages), Bussum, NGI.

Nowading, D.C. (1980) 'Inbound Materials Management', *Survey of Business*, Spring, pp. 18-25.

Office (1978) 'AutoTrain's accounting system', *Office*, Vol. 88, No. 1, July, pp. 95, 176.

Page-Jones, M. (1988) *The Practical Guide to Structured Systems Design*, Englewood Cliffs: Prentice-Hall.

Parasuraman, A. (1981) 'Use of Computers in Purchasing: An Empirical Study' *Journal of Purchasing and Materials Management*, Vol. 17, Spring, pp. 10-14.

Pelter, E.M. (1985) 'VQMIS Spells QUALITY', *Manufacturing Systems*, November, pp. 28-31.

Pinkerton, J. (1986) *Profitable Purchasing Strategies: Latest Techniques for Effective Cost Control*, Maywood, New Jersey: Modern Business Reports/Alexander Hamilton Institute, Inc.

Plank, R.E., Reid, D.A., Kijewski, V. and Lim, J.-S. (1992) "The Impact of Computer Usage by Purchasing," *Industrial Marketing Management*, Vol. 21, pp. 243-248.

Platford, R.J. (1986) 'Automatisering en inkoop: wat biedt de toekomst?' (Eng: 'Automation and purchasing: what does the future offer?') *Tijdschrift voor Inkoop & Logistiek*, Vol. 2, No. 4, pp. 4-7.

Pooler, V.H. (1992) *Global Purchasing: Reaching for the World*, New York: Van Nostrand Reinhold

Porter, R.W. (1989) 'Why purchasing can't get the systems it needs' *Purchasing*, May 4, pp. 96B12-96B15.

Porter, R.W. (1991) *Purchasing systems for the '90s*, Newton, Mass.: Purchasing Magazine.

Porter, R.W. (1993) 'What kind of purchasing system in Purchasing 2000?' *Purchasing*, May 20, pp. 32-42.

Purchasing & Supply Management (1995) 'Survey suggests weaknesses in IT procurement' *Purchasing & Supply Management*, January, p. 13.

Purchasing Magazine (1987) 'Computers in Purchasing: Buyers Expect More Now' *Purchasing Magazine*, Vol. 103, No. 16, (July 30, 1987), pp. 16-17.

Renkema, T.J.W. (1996) *Investeren in de informatie-infrastructuur: Richtlijnen voor besluitvorming in organisaties* (Eng: Investments in the information infrastructure: directives for decision making in organizations), Eindhoven: Eindhoven University of Technology.

Ribbers, P.M.A. (1980) *Planning en Organisatie van de Inkoopfunctie in de Industriële Onderneming* (Eng: Planning and Organization of the Purchasing Function in Industrial Companies), Diepenbeek: V.W.O.L.

Ribbers,, A.M.A. and Verstegen, M.F.G.M. (1992), *Toegepaste logistiek* (Eng: Applied logistics). Deventer: Kluwer Bedrijfswetenschappen.

Rijn, Th.M.J. van (1986) *Produceren door informeren: informatie-eisen voor verschillende produktiesituaties* (Eng: Producing through informing: information requirements in different production situations), Deventer: Kluwer.

Robinson, P.J., Faris, Ch.W. and Wind, Y. (1967) *Industrial Buying and Creative Marketing*, Boston: Allyn & Bacon.

Rokovich, J.E. and Hess, L.G. (1980) 'NASA Automated Purchase Order System' *Journal of the Society of Research Administrators (SRA)*, Vol. 12, No. 3, Winter, pp. 33-36.

Ronen, B. and Trietsch, D. (1988) 'A decision support system for purchasing management of large projects' *Operations Research*, Vol. 36, No. 6, November-December, pp. 882-890.

Roos, H.J. de, Waling, H.G. and Zoetmulder, E.O. (1991) *Inkoopmanagement in Nederland: Een onderzoek naar de inkoopfunctie in 99 bedrijven* (Eng: Purchasing management in the Netherlands: A survey of the purchasing function in 99 companies), Amsterdam: Bakkenist Management Consultants, pp. 24.

Rowe, C.J. (1988) 'Computer Awareness Among Functional Managers' IMDS, September-October, pp. 4-18.

Royen, E.J.G. van (1991) *Philips en zijn toeleveranciers* (Eng: Philips and its suppliers), Eindhoven: Kamer van Koophandel voor Zuidoost-Brabant.

Sako, M. (1991) *Prices, Quality and Trust: How British and Japanese Companies Manage Their Buyer-Supplier Relationships*, Cambridge: Cambridge University Press.

Scheer, A.-W. (1989) *Enterprise-Wide Data Modelling: Information Systems in Industry*, Berlin: Springer-Verlag, pp. 328-358.

Scheuse, T. (1994) 'DV-Systeme als Instrument im Einkauf' *Beschaffung Aktuell*, No. 3, pp. 52-54.

Schneider, R.M. and Murphy, J.F. (1987) 'Automated materiel management systems' *Hospital Materiel Management Quarterly*, Vol. 8, No. 3, pp. 40-47.

Schuchart, E. (ed.) (1987) 'Inkoop-oriëntatie voor bedrijven via computer' (Eng: 'Purchasing orientation for companies by means of the computer') *Input (CMG Magazine)*, Vol. 5, No. 4, pp. 1-2.

Senn, J.A. and Dickson, G.W. (1974) 'Information System Structure and Purchasing Decision Effectiveness', *Journal of Purchasing*, Vol. 10, August, pp. 52-64.

Shaughnessy, T.E. (1975) 'Using MIS to Improve Supply Management', *Journal of Purchasing and Materials Management*, Vol. 11, Winter, pp. 22-29.

Shore, B. (1981) 'A Micro-computer Based Purchasing Information System', *Journal of Purchasing and Materials Management*, Vol. 15, Summer, pp. 8-12.

Slater, H. (1994) 'Purchasing Improvement: Purchasing Information Plan — Medical Systems' *Purchasing Information Bulletin (PIB)*, Eindhoven: Philips Corporate Purchasing, pp. 9-11.

Southey, P.J. and Smith, A. (1995) 'Re-engineering the Supply Chain — The SMAC Project' in Cox A. (ed) *Proceedings of the 4th International Annual IPSERA Conference*, Birmingham, UK, April 1995.

Spekman, R.E., Kamauff, J.W. and Salmond, D.J. (1994) 'At Last Purchasing is Becoming Strategic' *Long Range Planning*, Vol. 27, No. 2, pp. 76-84.

Steele, P.T. and Court, B. (1996) *Profitable purchasing strategies: A manager's guide for improving organizational competitiveness through the skills of purchasing*, London: McGraw-Hill International (UK) Ltd.

Steering Group Purchasing Large Companies (1987) *Professioneel inkopend Nederland: nu en straks* (Eng: Professionally Purchasing Netherlands: Now and Later), Deventer: Kluwer Bedrijfswetenschappelijke Uitgaven

Stern, G.M. (1995) 'IndustryNet' *Link-Up*, March/April, p. 10.

Telgen, J. (1994) *Inzicht en overzicht: de uitdagingen van Besliskunde en Inkoopmanagement* (Eng: Insight and overview: the challenges of decision theories and purchasing management), Enschede: University of Twente.

Theeuwes, J.A.M. (1990) *Informatieplanning* (Eng: Information planning), Deventer: Kluwer.

Timbers, M.J. (1970) 'Status of Computer Development Activity in Purchasing' *Journal of Purchasing*, Vol. 6, November, pp. 45-64.

Verstegen, M.F.G.M. (1992) *Logistieke Automatisering 1992: Top Line Findings* (Eng: Logistics Automation 1992: Top Line Findings), Proceedings of the Day of Logistics Automation, October 15, Breda: Heliview Marketingservice.

Vokurka, R.J., Choobineh, J. and Vadi, L. (1996) 'A prototype expert system for the evaluation and selection of potential suppliers' *International Journal of Operations and Production Management*, Vol. 16, No. 12, pp. 106-127.

Vollman, Th.E., Berry, W.E. and Whybark, D.C. (1984) Manufacturing Planning and Control Systems, Homewood, Ill.: Dow Jones Irwin.

Webster F.E. and Wind, Y. (1972) *Organizational Buying Behaviour*, Englewood Cliffs, NJ: Prentice Hall.

Weele, A.J. van (1994) *Purchasing management: analysis, planning and practice*, London: Chapman and Hall.

Weele, A.J. van and Hespen, J. van (1987) *Inkoopfunctie in industriële ondernemingen* (Professioneel inkopend Nederland nu en straks: resultaten van onderzoeksproject inzake de ontwikkeling van de inkoopfunctie in Nederland; deelrapport 1) (Eng: The purchasing function in industrial companies), Deventer: Kluwer, pp. 131.

Weele, A.J. van and Rozemeijer, F.A. (1996) *Revolution in Purchasing*, Eindhoven: Philips Electronics—Corporate Purchasing, pp. 142.

Widing, J.W. and Diamond, G.C. (1964) 'Buy by Computer' *Harvard Business Review*, Vol. 42, March-April, pp. 111-113.

Womack, J.P., Jones, D.T. and Roos, D. (1990) *The machine that changed the world*, New York: MacMillan.

Workflow Magazine (1995) 'Produktoverzicht' (Eng: Product Overview) *Workflow Magazine*, Vol. 1, No. 1, pp. 35-36.

Wortmann, J.C. (1984) 'How to select a standard package for production/inventory control' *Advances in Production Management Systems*, Doumeingts, G., and Carter, W.A. (eds.), Amsterdam: Elsevier Science Publishers BV.

Yin, R.K. (1989) *Case Study Research: Design and Methods* (Applied Social Research Methods Series, Vol. 5), Newbury Park: Sage Publications.

Yoo, S. (1989) 'An Information System for Just-In-Time' *Long Range Planning*, Vol. 22, No. 6, pp. 117-126.

Yourdon, E. (1982) *Managing the System Life Cycle*, New York: Yourdon Press.

Yourdon, E. (1994) *Object-Oriented Systems Design: An Integrated Approach*, Englewood Cliffs: Prentice-Hall.

Zachman, J.A. (1987) 'A Framework for Information Systems Architecture' *IBM Systems Journal*, Vol. 26, Iss. 3, pp. 276-292.

Zenz, G.J. (1994) *Purchasing and the Management of Materials*, New York: John Wiley & Sons, Inc.

Zwaan, A.H. van der (1990) *Organisatie-onderzoek: leerboek voor de praktijk: het ontwerp van onderzoek in organisaties* (Eng: Organizational research in practice: the design of research in organizations), Assen: Van Gorcum.

Stellingen

behorende bij het proefschrift

Information Technology for Purchasing

van

Rob H.A. van Stekelenborg

Eindhoven, 24 september 1997

I

Tot op heden wordt informatietechnologie vrijwel uitsluitend in de veelal arbeidsintensieve operationele verwerving ingezet. Dit gebeurt dan veelal vanuit het oogpunt van efficiëntie.

(dit proefschrift, hoofdstuk 2 en 3)

II

Om beter bij de ontwikkelingen in de inkoopfunctie aan te sluiten zou informatietechnologie tegenwoordig meer moeten worden ingezet ter verbetering van de effectiviteit van initiële inkoopbeslissingen.

(dit proefschrift, hoofdstuk 4)

III

In tegenstelling tot de veel gebezigde stelling dat initiële inkoop zich niet leent voor geautomatiseerde ondersteuning, biedt informatietechnologie tegenwoordig goede mogelijkheden om ook aan de initiële inkoop ondersteuning te bieden.

(dit proefschrift)

IV

Inkoopondersteunende informatiesystemen dienen onderscheid te maken tussen functionaliteiten ter ondersteuning van inkoop- respectievelijk inkoopmanagementtaken.

(dit proefschrift, hoofdstuk 7,
zie ook Platier, E.A.H. (1996) *Een logistieke kijk op bedrijfsprocessen*.
Proefschrift Technische Universiteit Eindhoven)

V

Inkoopondersteunende informatiesystemen dienen ondersteuning te bieden aan het vastleggen en gebruiken van gevalsonafhankelijke referentiegegevens, en van beslissingsregels over het gebruik van deze gegevens in specifieke gevallen.

(dit proefschrift, hoofdstuk 7)

VI

Inkoopondersteunende systemen moeten het efficiënt vastleggen van een groot aantal varianten van inkoopwerkwijzen en het snel en eenvoudig aanpassen hiervan tijdens de uitvoering mogelijk maken.

(dit proefschrift, hoofdstuk 7)

VII

De toepassing van generieke objectmodellen in andere dan de 'traditionele' stuklijsttoepassing verdient aanbeveling.

(dit proefschrift, hoofdstuk 7 en 10)

VIII

In plaats van veel energie te steken in het bewerkstelligen van een kortere time-to-market om nieuwe producten eerder op de markt te kunnen introduceren zouden ondernemingen ook kunnen overwegen gewoon eerder te beginnen.

IX

Gezien de successen die in de praktijk zijn behaald met het werken met multidisciplinaire teams, verdient het aanbeveling bedrijfskundig onderzoek door een multidisciplinair team van onderzoekers te laten uitvoeren die hierover ook gezamenlijk rapporteren.

X

Het streven van de bedrijfskundige ingenieursopleidingen in Nederland meer 'techniek'[1] in hun curriculum op te nemen moet afgewogen worden tegen de aandacht en de status die de bedrijfskundige 'techniek'[2] zelf behoort te verdienen.

[1] Zoals bijvoorbeeld werktuigbouwkunde, informatica, elektrotechniek en chemische technologie.

[2] De kennis en vaardigheden om bedrijfskundige oplossingen te ontwerpen en te implementeren. Hierbij spelen zowel inhoudelijke aspecten (op gebieden zoals bijvoorbeeld strategie, marketing, innovatie, productontwikkeling, kwaliteitsbeheersing, inkoop, logistiek, etc.) als procesmatige aspecten (zoals bijvoorbeeld project management, veranderingsmanagement, organisatie, leiderschap, besluitvorming, cultuur, etc.) een belangrijke rol.

XI

Het is opmerkelijk dat een afgestudeerd bedrijfskundig ingenieur een 'bedrijfskundige' wordt genoemd terwijl een doctorandus filosofie niet als 'filosoof' wordt aangeduid.

XII

Het invoeren van de prestatiebeurs en het aanscherpen van de prestatienormen heeft geleid tot een vermindering van het aantal in het studentenleven actieve studenten, en daarmee tot een gemiddeld lagere kwaliteit van de afgestudeerden.

XIII

Het rendement van verworven inzicht zit hem niet zozeer in het direct toepassen van de nieuw verworven kennis in hetzelfde domein, maar veeleer in de toepassing ervan in andere domeinen.

(naar: Mayer, R.E. (1981) 'The Psychology of How Novices Learn Computer Programming,' *ACM Computing Surveys*, Vol. 13, No. 1, March, p. 123)

XIV

De discussie rondom het fileprobleem op de Nederlandse snelwegen moet zich niet zozeer bezighouden met de verhoging of verlaging van de maximum snelheid, maar met de vraag hoe verschillen in snelheden zoveel mogelijk kunnen worden voorkomen.

XV

Diegene die snurkt valt altijd als eerste in slaap.

Although the strategic profile of purchasing in industry has mostly been acknowledged by now, it seems as if purchasing's 'ool box' has not been aligned to this new role yet. This study thereby focuses on the use of tools based on information technology (IT). From the beginning of the adoption of IT in business, purchasing has been perceived to lag behind in reaping the fruits that present-day IT tools can provide.
This study provides purchasing professionals with a comprehensive entry into the field of IT for industrial purchasing. It answers questions about the current state of affairs in applying IT in purchasing and the reasons for this situation, and it provides design directives that can serve as a guide in deciding how IT can be deployed to effectively support the contemporary purchasing function. In this way this study supports the effective and efficient development and selection of information systems for the industrial purchasing function.

About the Author

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