MASTER

An integrated European stocking strategy for spare parts and an implementation of the principles of the VED analysis into the stocking strategy

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Abstract

Digital Equipment Corporation is a large multinational which develops, manufactures, sells, supports and services computer systems, peripherals and software. A multi-echelon distribution and repair structure is used to supply customers with spare parts. Besides investigating the criticality of spare parts with respect to the service process, a tool to support the design of an integrated European stocking strategy for spare parts is developed. Application of this tool can lead to a considerable reduction of investments in stock.

Management summary

This report describes the assignment that has been carried out during a nine month graduation project at the European Services and Supply Center (ESSC) of Digital Equipment Corporation in Nijmegen. This project is the final phase of the study Industrial Engineering and Management Science at the Eindhoven University of Technology.
The ESSC is one of the two International Logistic Organizations (ILO) of the division Multivendor Customer Service (MCS). This division is responsible for the support of Digital products and products of other brands, which includes the supply of spare parts towards customers. The ESSC in Nijmegen is the main distribution and repair center for spare parts in Europe, the Middle East and Africa. Its main responsibility is the procurement, warehousing and distribution of Digital and non Digital spare parts respectively for and to the stocking points in the countries.

Since a considerable amount of capital is invested in inventories in Nijmegen and in the countries, Digital is searching for ways to reduce inventories while maintaining or even improving service performance. During recent years Digital started a number of projects to investigate the impact on service performance and logistic costs of certain measures with regard to the supply chain. Most of these projects were either restricted to a certain part of the supply chain or were restricted to a specific distribution strategy. At the moment there is a need for a more common and integrated approach of the different supply chain projects in order to minimize logistic costs under the restriction of a required service performance.
Initially, the assignment was aimed at the development and implementation of a decision support tool to determine the optimal distribution strategy for spare parts. The optimal solution should be based on service performance and total logistic costs. However, for several reasons an *optimizing* mathematical model that covers the whole supply chain will be very difficult to develop, implement and maintain. The main reason is that conventional inventory control methods, known as Statistical Inventory Control (SIC), are not applicable to the major part of the assortment of spare parts. The conventional methods are based on statistical models striving for optimization, but the suitability of these models decreases with the decrease of the frequency of demand. As the bigger part of the spares assortment at Digital has low to very low demand, it is clear that one cannot speak of an optimizing model when conventional methods are used. Further research into specific 'company made' mathematical models, in which 'exotic' distribution functions are used to approximate low demand levels, learns that these models are very complicated and hard to implement and hard to maintain.
Furthermore, it became clear that not only demand patterns, but especially the importance (*criticality*) of spare parts for the service process should determine the stocking strategy. Therefore, further investigation into the criticality of spare parts by means of the VED analysis has been agreed upon.

The final assignment of the graduation project is formulated as:
Investigate the possibilities of implementing the VED model or its principles into the stocking strategy and develop, based on the results of the investigation, a framework for the stocking strategy.
After that, develop a tool to support the design of an integrated European stocking strategy for spare parts.

So, the research question of the graduation project is focused on an European integrated stocking strategy for spare parts. During the project an answer has to be found to the following two questions:

1. Which spare parts have to be stocked?
2. How much stock has to be maintained of those parts and where do they have to be stocked?

The first part of the assignment is restricted to the warranty service with regard to Compaq products, which is a part of the business of MCS. The second part, the development of a tool to support the design of an integrated stocking strategy, is carried out on the present infrastructure of the supply chain. This means that no attempt will be made to define new locations for stocking rooms or a new ILO. Moreover, only the echelons Nijmegen (ESSC) and the stocking rooms in the countries (SSPs) will be taken into account. The remote locations and business stocks at customer site will be neglected.

The first part of the project focuses on the development of a framework which can be used to classify spare parts according to their importance for the service process. A good method to group parts according to their criticality is the VED analysis, which aims at classifying spare parts as *Vital, Essential* and *Desirable* for the service process. Several important factors in the spare parts environment in which Digital operates have been determined and those factors have been investigated with respect to their suitability for classifying parts as vital, essential or desirable. The framework, resulting from this part of the assignment, can be used to solve the first issue: "Which spare parts have to be stocked?".

In the second part of the project a spreadsheet has been developed that supports the design of an integrated European stocking strategy. Again, a framework underlies the development of the spreadsheet. By applying the spreadsheet, answers can be found to the second issue: "How much stock has to be maintained of those parts and where do they have to be stocked?". The spreadsheet provides insight in the investments in stock necessary to acquire a pre-specified Level Of Service and shows the impact of the stocking location on the average lead time to the customers. Moreover, the influence of the contracted service response times on the stocking strategy can be showed.

In this report a number of conclusions have been drawn, which are summarized below.

Conclusions

1. *For the customer service the consumption in pieces is more important than the consumption in dollars.*

Therefore, the decision whether or not to stock parts must not be based on turnover (classic Pareto analysis), but must be based on consumption (in pieces).

2. *Important factors with respect to the criticality of spare parts are:*
    - *service response time*
    - *functionality*

The service response time is defined as the time that is allowed for spares to arrive at a customer after a customer has called. The service response time is determined by the service contracts with customers.
According to the factor functionality a spare part is either 'functional' or 'cosmetic'. Functional means that when a part breaks down, also the system to which it belongs breaks down. A failure of a cosmetic part does not influence the operation of the system to which it belongs.

3. *At the moment the factor 'service response time' is not suitable for classifying parts as vital, essential or desirable.*

This is due to the fact that a spare part can occur in different products for which different response times can be contracted by different customers.

4. *The decision not to stock cosmetic parts can considerably decrease the investments in stock.*

With respect to January 1997, not stocking cosmetic Compaq parts, would result in a decrease of approximately $ 128,000 (2.6% of total) invested in stock. Noticing the fact that the business for Compaq only concerned 1886 partnumbers at that moment, the possible savings (decreases of investments) can be much higher for the entire Digital assortment.

5. *With respect to the question "how much and where to stock parts?", the most important factors are:*
   - *usage (in pieces);*
   - *price;*
   - *service response time.*

Although being an important factor, the 'service response time' can not be used for answering this question, due to the fact mentioned under conclusion 3. Next to some other parameters, the first two factors have been used in a direct way to develop a spreadsheet, which supports the design of an European integrated stocking strategy. However, by applying the spreadsheet it is possible to show the impact of the service response time on the investments in stock.

6. *In general the stocking strategy can initially be focused on the interest costs or, in other words, on the investment in stock.*

This has been determined by means of two product characteristics of computer spare parts. The two product characteristics are 'the value density' and 'the packaging density'.

7. The service response time has a huge impact on the required investments in stock.

The impact of the service response time on the investments in stock can be shown in an indirect way by means of the spreadsheet. The shorter the response time, the more locally parts have to be stocked.

8. The first results of the calculations with the spreadsheet show that there are extensive possibilities to decrease the investments in stock.

Due to time restrictions, it was not possible to determine the ultimate stocking strategy. However, the calculation of some scenarios led to the conclusion that a decrease of more than 20 million dollar, invested in stock throughout Europe, is possible. The calculations of the spreadsheet were compared with the investment in stock in February 1997, concerning 30,000 partnumbers.

Preface

This paper describes the assignment, carried out during a nine month graduation project at the European Services and Supply Center of Digital Equipment Corporation in Nijmegen. This project is the final phase of the study Industrial Engineering and Management Science at the Eindhoven University of Technology, Faculty of Technology Management.

I would like to thank everybody at the European Services and Supply Center for their cooperation and for giving me the opportunity to work in a friendly and professional environment.
Especially, I would like to thank my coach at Nijmegen Bert Crowe, Customer Engagement Manager, for his support and for giving me the opportunity to carry out this graduation project.
Furthermore, I would like to thank my mentors of the Eindhoven University of Technology for their support and valuable comments during the project:

Ir. P.P.J. Durlinger	first mentor of the Eindhoven University of Technology,
Dr. P.C. Sander	second mentor of the Eindhoven University of Technology.

Finally, I would like to thank Dr. ir. L. Fortuin of the Eindhoven University of Technology for his advice, which was a great support for me.

René Botter
Nijmegen, May 1997

Contents

1 Introduction

This report deals with the assignment, carried out during a nine month graduation project at the European Services and Supply Center (ESSC) of Digital Equipment Corporation in Nijmegen. This project is the final phase of the study Industrial Engineering and Management Science at the Eindhoven University of Technology.
Digital Equipment Corporation is a large multinational company which develops, manufactures, sells, supports and services computer systems, peripherals and software. In order to support the installed base throughout the product life cycle, Digital has a multi-echelon distribution- and repair structure to supply the customers with spare parts.
The ESSC in Nijmegen is the main distribution and repair center for spare parts in Europe, the Middle East and Africa. Its main responsibility is the procurement, warehousing and distribution of Digital and non Digital spare parts respectively for and to the stocking points in the countries. The ESSC also advises the countries on their logistics to enable a better use of the European stock.

During recent years Digital started a number of projects to investigate the impact on service performance and logistic costs of certain measures with regard to the supply chain. Most of these projects are either restricted to a certain part of the supply chain or are restricted to a specific distribution strategy. At the moment there is a need for a more common and integrated approach of the different supply chain projects, in order to minimize logistic costs under the restriction of a required service level.
Digital wants a tool that supports the design of an integrated European stocking strategy for spare parts. This tool should answer the questions:

- Which parts have to be stocked?;
- How much stock has to be maintained of those parts and where do they have to be stocked?

The answers to this question should be based on a pre-specified Level Of Service and must indicate the logistic costs that goes along with a particular stocking strategy.

As it became clear that not only demand patterns, but especially the importance (or *criticality*) of spare parts for the service process are determining the stocking strategy, further investigation into the criticality of spare parts by means of the VED analysis was agreed upon.

The final assignment was defined as:
Investigate the possibilities of implementing the VED model or its principles into the stocking strategy and develop, based on the results of the investigation, a framework for the stocking strategy.
After that, develop a tool to support the design of an integrated European stocking strategy for spare parts.

Chapter 2 describes the company and the relevant product- and market characteristics and depicts the European supply chain. The development of the assignment is included in chapter 3. Chapter 4 provides an outline of the VED model and the Analytic Hierarchy Process, that can be used together with the VED analysis. The research into the possibilities of implementing the VED model or its principles into the stocking strategy at Digital is presented in chapter 5. Chapter 6 gives an overview of the development of the tool, that must support the design of an integrated European stocking strategy. Chapter 7 contains conclusions and recommendations based on the research performed.

2 General setting

2.1 Digital Equipment Corporation

Digital Equipment Corporation, also known as DEC, is a large multinational which develops, manufactures, sells, supports and services computer systems, peripherals and software.
Digital Services, one of the five divisions (see appendix 1) of Digital Equipment Corporation, is responsible for the worldwide support of the installed base throughout the product life cycle. Support of the installed base covers a wide range of activities, such as: the design and installation of networks, system integration, upgrading and maintenance of installed soft- and hardware. The after sales activities are not restricted to Digital products only. More and more customers are confronted with an installed base consisting of different brands, leading to a large number of service contracts. Therefore Digital decided a few years ago to provide its customers brand independent maintenance in order to fulfill their growing need of multi brand support.

2.2 Digital Services

The Digital Services division is divided into three business units (see appendix 1). Multivendor Customer Services, one of these units is divided into seven branches. The logistics branch is called Global Supply Operations (GSO) and is divided geographically into sub-branches. One of these sub-branches is GSO Europe. The organization of GSO Europe is depicted in appendix 2.
The purpose of GSO Europe is to provide logistics and acquisition goods and services at competitive costs to the customers.
GSO Europe has the disposal of a multi-echelon repair- and distribution structure (figure 1) which consists of an International Logistic Organization (ILO), located in Nijmegen (ESSC), Service Stocking Points (SSP), Remote Locations and a number of repair centers located in different territories throughout Europe. Each territory consists of one or more countries (appendix 4) which are relatively autonomous with regard to their logistic operations.

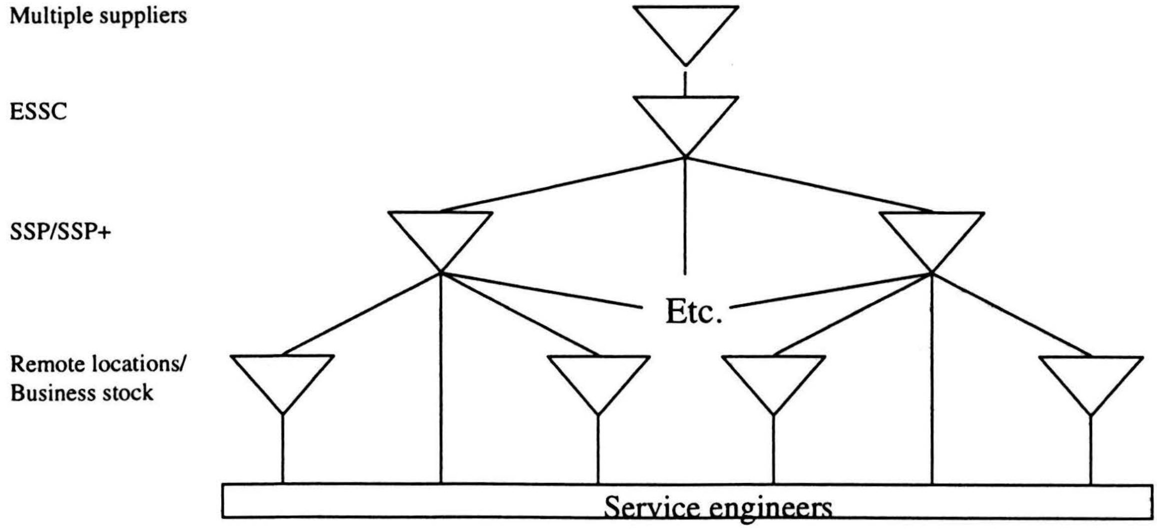

Figure 1 Multi-echelon distribution structure GSO Europe

The countries are responsible for the spare part distribution to the contracted customers. The number of echelons and the number of stocking points per echelon varies per country. In most countries of Europe the lowest echelon consists of Service Stocking Points (SSP) and one Service Stocking Point *Plus* (SSP^+). Service engineers collect the bigger part of the spare parts at these stocking points for repair of computer systems in the region. A minor part is delivered to the engineers by taxi. The country repair center is located at the SSP^+. However, some European countries have an extra echelon below the $SSP^{(+)}$ level with stocking points called Remote Locations, which are supplied by the $SSP^{(+)}$s.

The service engineers do carry some stock in their cars, but only on a temporary basis ("on loan"). The loan time varies per country from a number of days to a couple of weeks. When customers demand very short response- or restoral times, for example one hour or less, it is decided to keep some stock at customer site. This stock, called Business Stock, is usually only available for that particular customer.

The ESSC in Nijmegen is the next higher echelon above the SSP level. The ESSC supplies the SSPs and SSP^+s with spare parts. In a few territories or countries spare parts are being delivered to the $SSP^{(+)}$s via a hub, also called Transport Optimization Point (TOP).

2.3 European Services and Supply Center

The European Services and Supply Center (ESSC) in Nijmegen is the main distribution and repair center for spare parts in Europe, the Middle East and Africa. Being one of the two ILOs in the world, its main responsibility is the procurement, warehousing and distribution of Digital and non Digital spare parts respectively for and to the stocking points in the countries. The ESSC also advises the countries on their logistics to enable a better use of the European stock.

Next to the distribution function the ESSC has three other important functions. Firstly, returned defect spare parts are repaired in the Repair Service Center of the ESSC (RSC) so they can be used again for maintenance. These parts are mostly Digital parts. Secondly, old computer systems and defect spare parts which are economically or technically not repairable are disassembled and scrapped at the ESSCs European Material Disposal Center (EMDC). Usable parts are stocked or sold to third parties. The last function of the ESSC is the refurbishment and upgrading of used computer systems (TREG).

Within GSO Europe the ESSC is considered as a separate territory and works on a non-profit base. The countries buy their spare parts at purchase price with an uplift to cover the costs of the ESSC. The countries are still free to purchase spare parts wherever they want but remain the owner of their stock and are responsible for inventory costs and related service performance. Appendix 3 shows the organization of the ESSC within the GSO Europe framework.

2.4 Product characteristics

The product assortment of Digital is divided into six product categories which are listed in table 1. Software products are not considered here.

Category	Families
Personal Computers	personal computers, PC servers
Systems: Mid End	workstations, Alphas, minicomputers
Systems: High End	mainframes, VAX systems
Component & Peripherals	alpha chips, printers, monitors
Storage	hard disks, disk drives
Networks & Communications	LAN/WAN, ethernet cards, satellite systems

Table 1 Product categories of Digital

Each product category consists of several families. For example the Alpha systems together represent a family in the Mid End category. Each family consists of several systems with each a different design, for example the Alpha-7000. A system can be equipped with different options which is the lowest saleable part in a certain system. For example a disk drive, the memory and the processor.
Systems and their built in options consist of several modules, called Field Replaceable Units. An example of an FRU is a read-and-write logic of a disk drive. FRUs are, in their turn, composed of several components such as chips and fuses.

The product of the MCS organization covers the maintenance of the above mentioned product categories and comparable products of other suppliers based on service contracts. In order to support the installed base, service engineers must have spare parts at their disposal at the right time and at the right place. In this context a spare part can refer to a system, an option or a Field Replaceable Unit. Spare parts can be divided into two categories:

- **Repairables**: spare parts that are technically and economically repairable. These parts are swapped for a new one and sent to a repair center.
- **Consumables**: spare parts that are technically and/or economically not repairable. These parts will be scrapped after failure instead of being repaired.

Demand is split for repairables and consumables. Consumables go one way through the supply chain and are disposed after failure. Repairables return after repair into the distribution channel. Once a repairable is in the supply chain, GSO only looses it by scrapping or selling it on the market. Repairables are repaired at country, ESSC or supplier level depending on the characteristics of the part and available repair technology. If a spare part is repaired at country level the ESSC only sees part of the total European demand.

2.5 Goodflows in the supply chain of GSO Europe

Within the supply chain of GSO Europe several sub-flows can be identified.

2.5.1 Flow of new built and repaired spare parts towards service engineers.

This flow is driven by replenishment and by emergency orders of the various stocking points in the supply chain. The SSP[(+)]s or the Remote Locations supply service engineers with spare parts for repair at customer site. When the needed spare parts are on stock, they are allocated to the service engineer and immediately a replenishment order is created towards the ESSC or the SSPs in order to increase the inventory level to a recommended stock level. Spare parts for replenishment are shipped to the lower echelons using a consolidated transport network between the echelons.

An emergency order is used when the lowest echelon, SSP(+) or remote Location, does not have one or more of the demanded parts on stock. The demand at the lowest echelon is the customer demand, which results from a failure at the installed base of a customer. Emergency orders can be delivered from any echelon, even from the suppliers, to another echelon or customer. Parts ordered by emergency are shipped by taxi- or courier services.
Taxi- and courier shipments to the customer are also used when the demanded part is on stock at the SSP or Remote Locations, but it cannot wait to be picked up by the service engineer.

2.5.2 Flow of defective repairable spare parts towards repair centers.

After changing a defective part for a good one at customer site, the service engineer brings the defective parts back to the SSP or Remote Location where consumables are scrapped and repairables are sent to the SSP+. Repairables are, depending on the repair facilities, repaired at country level or sent to the ESSC. Both levels have an own repair shop or use external repair facilities. The ESSC repairs Digital parts at module- and option level. Countries mostly repair at option level, but also on module level in case of locally sourced parts.
Figure 2 depicts the replenishment- and repair flows of spare parts within the supply chain of GSO. In accordance with the supply chain model used in Nijmegen, figure 2 puts the customer first (left). Emergency flows and parts that return unused are excluded.

2.6 Control system

In this section the control system is described. This system determines the coordination of the flow of spare parts and the responsibilities for the distribution of spare parts.
Each territory, which consists of one or more countries, has an own territory manager who is responsible for the realized service performance and the related costs. Within a territory responsibilities are split for acquisition, inventory control and distribution & warehousing. The supply manager is responsible for the inventory control of the warehouses in the territory and reports to the territory manager as well as to the European Logistics Manager.
A Service Stocking Point (SSP) keeps its stock at a recommended (order-up-to) stock level called the Target Stock Level. When customer demand appears, the stock level will drop below the Target Stock Level and an order is automatically generated and placed for replenishment at the ESSC. This ordering procedure is called 'one for one replenishment' or (S-1,S) and is used because of the low demand rates and high unit prices. Remote Locations also use this procedure to replenish their stock of spare parts.
According to Sherbrooke (1992) one-for-one replenishment is the optimal policy for high cost, low demand items.

At the ESSC the responsibility for the distribution of spare parts is also split for inventory control and transport & warehousing. The Distribution & Warehousing section is responsible for the warehousing of the parts and shipping them from the ESSC to the service provider of a specific country. The Supply section is responsible for the amount of stock and the level of fill at the ESSC.

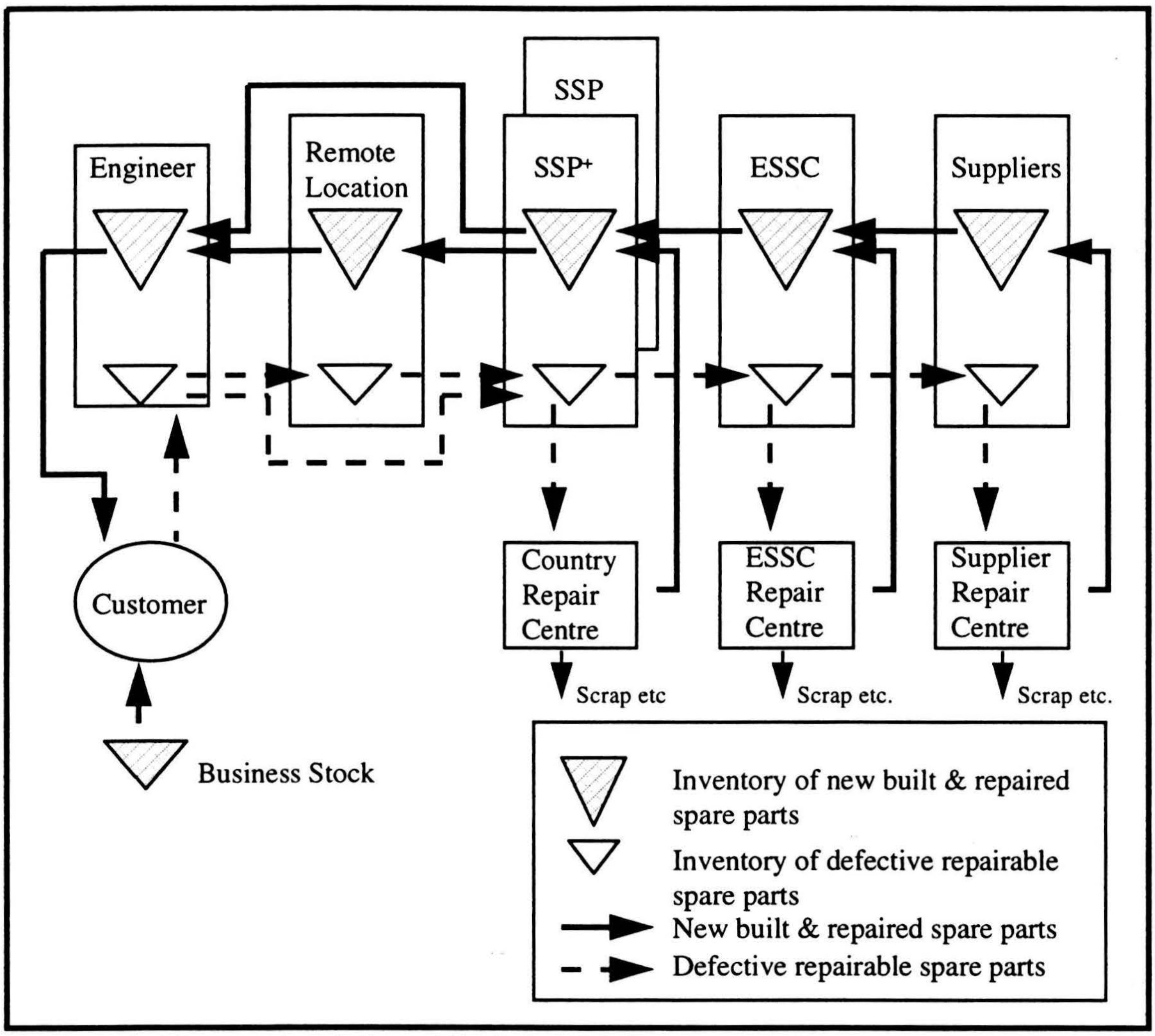

Figure 2 Replenishment- and repair flows within the supply chain

Planners at the ESSC weekly review the order suggestions of the logistic information system, called ManMan. These suggestions are based on a RsQ inventory control policy. The system reviews weekly (R) and orders a quantity of spare parts (Q) if the stock level has sunk below the reorder point (s). The order quantity is not restricted to a minimum order quantity.

2.7 Market

The industry in which Digital operates is characterized by a growing importance of after sales activities and strong competition in the hardware service market, especially in the brand independent maintenance segment in which Digital wants to maintain it's leading position. This competition leads to a high pressure on prices and operating margins of services offered. In order to gain competitive advantage, Digital has to provide flexible and effective services at low costs. To make this kind of services possible GSO has to have a distribution structure that delivers spare parts to the customers according to market demand at lowest possible costs.

Compared to other industries the demand for spare parts is relatively low and the average price per part is high. Furthermore, rapid technological changes and innovations have shortened the average life cycle of end products considerably and thereby the average life of spare parts. These product- and market characteristics lead to a high pressure on distribution management (external transport, inventory management and warehousing (Van Goor *et al.* (1994)).

3 Development of the assignment

3.1 Previous projects

During the last years Digital started a number of projects to investigate the impact on service performance and total logistic costs of certain measures with regard to the supply chain:

- There has been an investigation on the consequences of inventory ownership avoidance (Under what circumstances can non-ownership of inventory be cost beneficial to Digital?).
- A project called "Weeks On Hand (WOH) reduction" is going on. WOH is defined as 'inventory/consumption per week'.
- A Project named "SSP optimization" is going on. This project does not cover the whole supply chain, but is restricted to the Netherlands and will probably be extended to the Benelux.
- Several alternative distribution strategies have been or are still being investigated:
    * direct shipment from external suppliers to the SSPs;
    * direct shipment from internal suppliers to the SSPs;
    * centralization of stock from the SSPs to the ESSC (restricted to the Netherlands).

Most of these projects are either restricted to a certain part of the supply chain or are restricted to a specific distribution strategy.
At the moment there is a need for a more common and integrated approach of the different supply chain programs. Digital wants an optimizing decision support tool to cover the whole supply chain.

Initially the assignment was formulated as:
Develop and implement a decision support tool to determine the optimal distribution strategy for spare parts. The tool has to be applicable on management level and should cover the whole supply chain. Optimal solutions should be based on Level of Service (LOS) and total logistic costs.

Noticing this description as being too vague for a structured investigation further questioning made clear that Digital is interested in two main issues:

1. Which spare parts have to be stocked?;
2. How much stock has to be maintained of those parts and where do they have to be stocked?

The search for an answer to this questions should be based on a pre-specified service performance. In other words, Digital wants to know what has to be stocked in order to fulfill a certain pre-specified Level Of Service (LOS).

Furthermore, the strategic document, written in the fourth quarter of 1996, gave some more clearness about Digital's goals. A summary of this strategic document is given in the next section.

3.2 Strategic document

According to Digital customers want a wider range of services with respect to prices and LOS.
The customers want lower cost service options for *every* product as applications will determine criticality more often than the product itself. Therefore customers will choose the LOS they require for each application and try to reduce costs in the less critical areas.

Although customers have different requirements, till now GSO basically has one process for all. This process basically results in very high stock levels and high service costs.
So GSO must re-engineer the supply chain and develop new capabilities to meet the customer needs.

In the last quarter of 1996 a strategic document was written in which future plans for GSO Europe and especially for the ESSC are described. In this document a re-engineering of the European supply chain is proposed. Two key goals of the re-engineering plan are a better financial performance and a higher (custom made) LOS, or in other words, higher customer satisfaction.
In order to reach the goals four focus areas are determined:

- improvement of supplier performance;
- speeding up delivery by ILO;
- improvement of field stocking strategy;
- better contract support.

This report and the assignment will focus on the improvement of the field stocking strategy, although one has to keep in mind that this subject cannot be handled with, isolated from the other subjects.

In the strategic document a few key concepts are mentioned about the stocking strategy.
Based on the Pareto analysis it is stated that 90% of the LOS can be met from 10% of the parts. In other words, a few parts drive the LOS. In the strategic document the LOS is defined as the cumulative percentage of the total consumption of parts. Perhaps 'fill rate' would be a better word for this.
At the moment GSO has many part numbers in stock; a few with very high levels of consumption and many with very low levels of consumption (see figure 3).

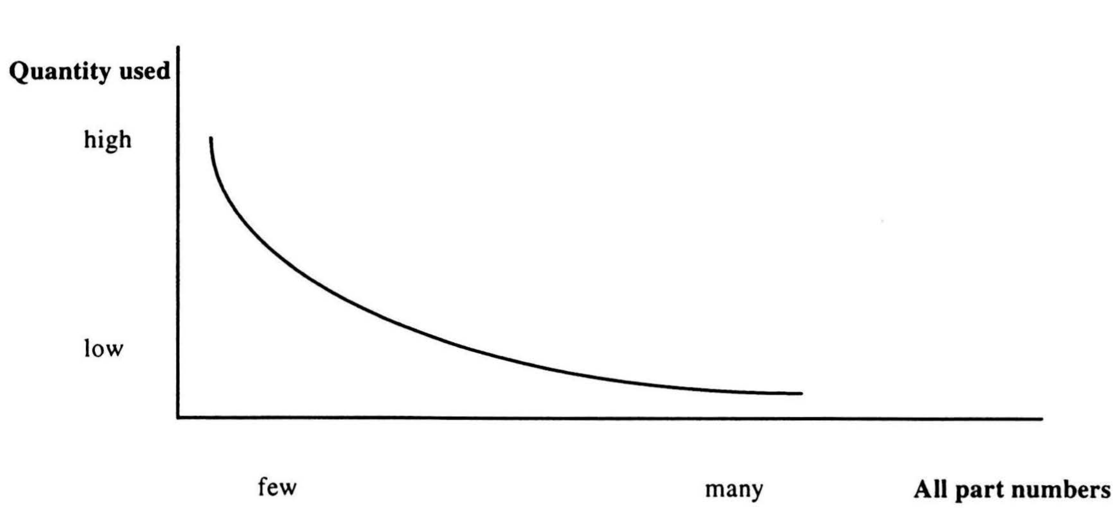

Figure 3 Consumption of parts

GSO wants to invest only in the parts that contribute the highest LOS. That means that GSO wants to tie stock levels to consumption to optimize LOS and investments. GSO uses the Average

Monthly Consumption (AMC) as parameter for the consumption and Weeks On Hand (WOH) as parameter for the stock level. WOH is defined as **inventory / consumption per week.**
The goal is to have low WOHs for fast movers, higher WOHs for slow movers and no stock for very slow movers. This is depicted in figure 4.

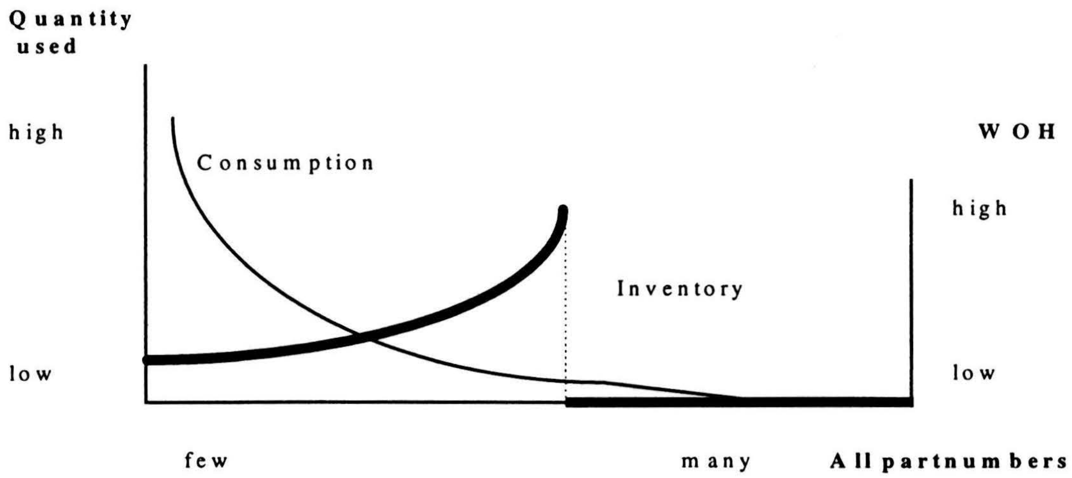

Figure 4 Consumption and stocking of parts

Low WOHs for fast movers does not automatically mean low numbers of parts on stock. Because the consumption rate is high for fast movers, a few WOH can still be a considerable stock. On the other hand most of the time higher WOH for slow movers will result in a low number of items stocked.
GSO wants to stock fast movers in every SSP, less fast movers in just a few central SSPs (SSP^+s) and slow movers in a central European warehouse (Nijmegen). Very slow movers are not going to be stocked at all, but will be sourced on demand.
The scheme depicted in figure 5 shows the way GSO defines the stocking strategy.

So far it is clear that Digital wants to determine its stock levels based on demand patterns and a pre-specified service performance.
The next question is what kind of management tool Digital would like to have. At first order an optimizing mathematical model that covers the whole supply chain was suggested. Because it was expected that such a model would be very difficult to develop, first extensive literature research was done to determine if that kind of models were already developed.

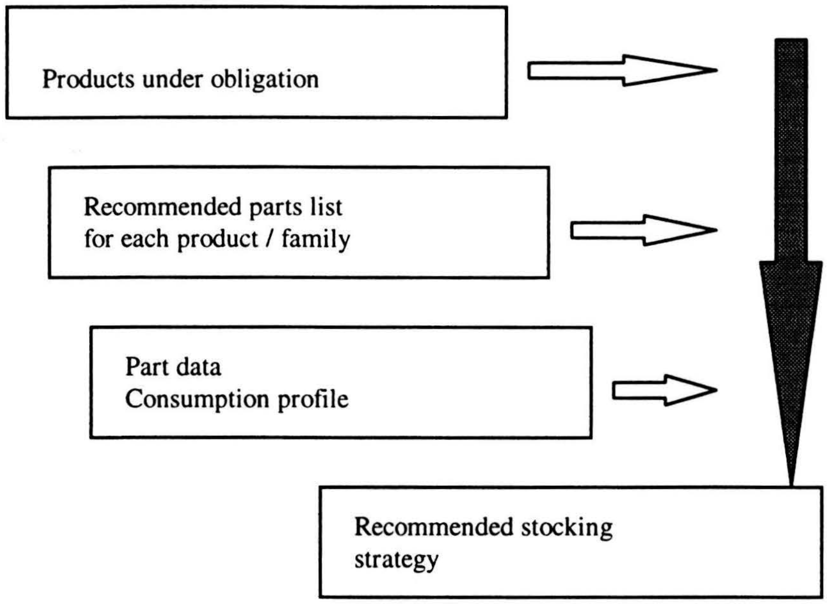

Figure 5 Determination of stocking strategy

3.3 Literature research

Literature research learned that conventional inventory control methods, known as Statistical Inventory Control (SIC), are not applicable to the major part of the assortment of spare parts. The conventional methods are based on statistical models striving for optimization. However, the suitability of these models decreases with the decrease of the frequency of demand. As a matter of fact they are suitable only for the small fraction of items with a high frequency of demand. As written in the previous sections the bigger part of the spares assortment has low to very low demand so this may lead to the conclusion that one model for the total menu is not feasible and a different approach is necessary.
Further research in specific 'company made' mathematical models, in which sometimes 'exotic' distribution functions are used to approximate low demand levels, learned that these models are very complicated and seemed hard to implement and hard to maintain (Botter, 1996). Such models could not satisfy Digital's wish for a tool applicable on management level, easy to use and with high maintainability.

The most important aspect learned from literature is that before coming to any conclusion about the level of stock of an individual spare part, it is necessary to decide on the importance of the part for the service process. In general the emphasis has to be on *criticality* of spare parts. Based on criticality spare parts can be classified as vital, less vital or 'not' important for the service process and appropriate levels of control can be established over each category.
At the simplest level, parts can be classified as fast or slow moving, but this is no real help in making stocking decisions for spare parts. This means that the demand pattern of spare parts, on which Digital determines it's stock levels at the moment (see figure 5), might not be the most important or at least not the only factor for determining stock levels.
The best advice is to group parts into categories that reflect their importance to the service process.
A method for grouping parts is the VED analysis. The VED analysis aims at classifying spare parts as *Vital*, *Essential* and *Desirable* from the point of view of their functional necessity

(criticality) in production or service operations. In general, vital spare parts include all items, which, if not on stock, could result in huge losses due to non-availability of the equipment needing the spare. Essential spare parts generally are those for which stock-outs could result in moderate losses (parts have to be available in short term). Non-availability of desirable parts will cause only minor disruptions (parts have to be available after a longer period of time).
The criticality of a spare part can be determined by various factors. Some important factors for the spare parts environment in which Digital operates are:

- contracted response times based on service contracts with customers for Digital and non-Digital products;
- functionality of spares: parts can be functional or cosmetic for a certain system;
- consumption;
- stage of the life cycle;
- price;
- purchase lead-time
- repairability.

Although criticality of an item is a very important subject to be considered for specifying service levels (or stock levels), especially in the case of spare parts inventory systems, evaluating the criticality of spares and group them is a difficult task, which is often accomplished using subjective judgments.
A systematic procedure which helps evaluating the criticality of spare parts is the 'Analytic Hierarchy Process' (AHP) developed by Saaty (1980). In the next chapter further attention will be paid to the VED model and AHP.

Digital agreed that criticality is an important aspect with respect to the stocking strategy. Till now the stocking strategy has only been based on the (expected) demand of spare parts.

3.4 Assignment

Based on the literature research it is decided not to develop one *optimizing* mathematical model to determine the stocking strategy for the total menu of spare parts. The main reasons for this are first of all the fact that Digital wants a tool for the total supply chain, hence a tool to cover all spare parts. Due to the low suitability of conventional inventory control methods for parts with a low frequency of demand, it is expected that one model cannot support all parts.
Secondly, a optimizing mathematical model including complicated distribution functions to predict low frequencies of demand and with numerous restrictions and assumptions is expected to be very difficult to develop, implement and maintain.

Digital agreed that criticality is an important aspect with respect to the stocking strategy. In the previous section it has been explained why demand is not the only important factor with respect to the stocking strategy. However, Digital also notices that the evaluation of criticality of spare parts is a very difficult task. Next to that, Digital wonders to what extend the VED analysis is applicable, because Digital has about 50,000 active partnumbers. Without any doubt this makes automation of the classification according to a VED model necessary. Digital questions to what extend such automated model is easy to implement and moreover, easy to maintain.

Nevertheless, Digital also sees advantages with respect to the VED model and agrees on further investigation into the possibilities of implementing the VED model or its principles into the stocking strategy.
The final assignment is formulated as:
Investigate the possibilities of implementing the VED model or its principles into the stocking strategy and develop, based on the results of the investigation, a framework for the stocking strategy.
After that, develop a tool to support the design of an integrated European stocking strategy for spare parts.

Because of time limitations the assignment has to be further restricted.
The first part of the assignment will be carried out on a part of the business of MCS. This part of the business is the warranty service with regard to Compaq products, which will be described in chapter 5.
The second part of the assignment, the development of a tool to support the design of an integrated stocking strategy, will be focused on the present infrastructure of the supply chain. This means that no attempt will be made to define new locations for stocking rooms or a new ILO. Moreover, only the echelons Nijmegen (ESSC) and the countries (SSPs) will be taken into account. The remote locations and business stocks at customer site will be neglected. To determine an integrated stocking strategy for spare parts, a relatively simple tool (spreadsheet) will be developed that provides insight in the investments in and locations of stock, necessary to acquire a pre-specified Level Of Service. This spreadsheet will be developed instead of a (complex) optimizing model that was proposed initially.

4 Outline of the VED model and AHP

4.1 Introduction

Inventory management of spare parts is a very important part of the activities of the ESSC in Nijmegen. If the parts are understocked, then the customers cannot be serviced within the contracted response time, resulting in customer dissatisfaction. On the other hand, if the parts are overstocked, the holding costs are high.
Conventional inventory control methods, known as Statistical Inventory Control (SIC), are based on statistical models striving for optimization. However, the suitability of these models decreases with the decrease of the frequency of demand. As a matter of fact they are suitable only for the small fraction of items with a high frequency of demand.
The majority of the assortment with a low to very low demand requires a different approach. This is the more important because it generally concerns items with a high price, which leads to a non negligible economic loss if inventory levels are set higher than necessary.

Before coming to any conclusion about the level of stock of an individual part, it is important to decide on the importance of the part for the service process. At the simplest level, parts can be classified as fast or slow moving, but this is no real help in making stocking decisions for spare parts.
The best advice is to group parts into categories that reflect their importance to the service process, and to establish appropriate levels of control over each category.
A method for grouping parts is the VED analysis. The VED analysis aims at classifying spare parts as *Vital*, *Essential*, and *Desirable* from the point of view of their functional necessity (criticality) in production or service operations. In general, vital spare parts include all items, which, if not on stock, could result in *huge losses* due to non-availability of the equipment or process needing the spare. Essential spare parts generally are those for which stock-outs could result in *moderate losses* (parts have to be available in short term). Non-availability of desirable spares will cause only *minor disruptions* but may lead to more serious operational problems in the long run.

4.2 VED analysis and the Analytic Hierarchy Process

The *criticality* of an item is a very important factor to be considered for specifying service levels, especially in the case of spare parts inventory systems.
Evaluating the criticality of spares is a difficult task which is often accomplished using subjective judgments. A systematic procedure which helps evaluating the criticality of spare parts is the 'Analytic Hierarchy Process'. AHP is a multi-criteria decision making tool developed by Saaty (1980) to find out the relative priorities or weights to be assigned to different criteria and alternatives which characterize a decision. The decision model is based on structuring the problem into a hierarchy with the overall objective (or focus) at the apex. Criteria which characterize the objective are located in the middle level, and the decision alternatives are located at the bottom level (see figure 6).
However, more levels could be added in the hierarchy between the overall objective at the top and the decision alternatives at the bottom, depending on the way a decision problem is structured.

Criteria and alternatives have to be determined by management. In case of Digital the overall objective can be: "Evaluation of the criticality of spare parts".

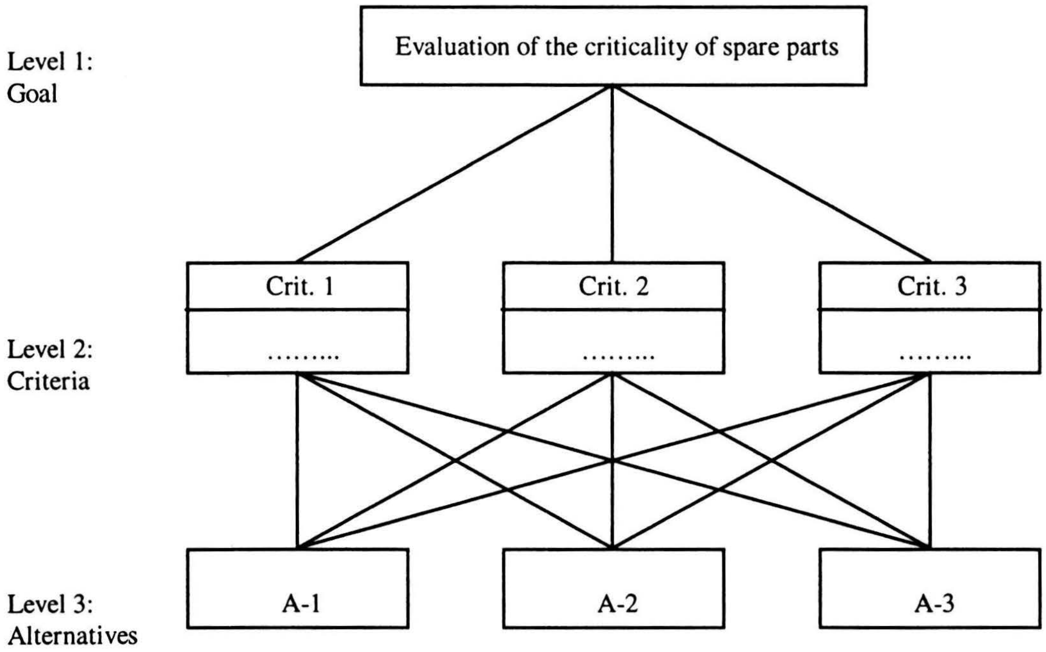

Figure 6 Hierarchy structure for VED analysis - AHP Model

Examples of possible criteria and alternatives applicable to spare parts for Digital are depicted in table 2.

Criteria	Alternatives
Contracted response times	> Next Business Day Next Business Day 2-4 hours
Life cycle	Introduction Maturity Decline
Consumption (Average Monthly Consumption)	AMC < 5 AMC > 5 AMC > 100
Purchase lead-time	LT < 1 week LT > 1 week LT > 3 weeks
Price	< $100 < $1000 > $1000

Table 2 Criteria and alternatives applicable to spare parts

As written before the criteria and alternatives have to be determined by management.

Once the hierarchical model has been structured for a given decision problem, *pairwise comparisons of criteria* with respect to the overall objective are made. This results in a comparison matrix. The calculation of the 'normalized principal eigenvector' (Kolman (1993)) of this matrix provides a measure of each criterion's relative importance to the decision maker in the light of the overall objective.
Similarly, the *decision alternatives are also compared pairwise* with respect to each criterion and the corresponding pairwise comparison matrices are obtained. These pairwise comparisons are made using the nine-point comparison scale suggested by Saaty (1980) (see appendix 6). The final priority or weight of each decision alternative is obtained using an aggregation procedure involving different numerical weights for each criterion. These weights can be used for the absolute measurement of the criticality of a spare part.
The absolute measurement of the criticality of a spare part depends on the characteristics of that particular spare part. In other words, the weight is determined after evaluating which alternative is applicable to the part corresponding to each criterion.

After determining the absolute value of criticality for a spare part, this value is compared with the *numerical limits*, specified by management, for classifying spare parts as Vital, Essential, or Desirable. These numerical limits have been specified by the management after due consideration of the impact due to non-availability of different spare parts. This last step, assigning the parts to the classes, can be automated very well, because spare parts and data about the relevant criteria and alternatives can be put in a database. The hierarchical model and the relative weights can be a permanent framework in the data base.
For a proper understanding of the Analytic Hierarchy Process it is recommended to read appendix 5, in which a general example has been worked out.

After the classification of the spare parts, appropriate levels of control can be established over each category. Establishing levels of control covers a broad range of possibilities.
First of all different service levels can be assigned; a high service level (>95%) for the vital parts and a low level for desirable parts.
Secondly, for parts in the vital class, management can decide to use sophisticated statistical inventory control models for the fast movers. For the slow movers in this class statistical methods are not appropriate but for sure it is clear that the parts are vital, so narrow management involvement is necessary. (For example management could decide to put at least two pieces of these parts on stock in every local warehouse.)
Also for the other two classes management can decide the way stocking and controlling has to be performed. Budgets can be determined for parts in these classes, decisions about stocking locations can be made (for example: don't stock desirable parts or just stock them centrally) and probably less stringent control rules can be applied.
Furthermore strategies with respect to transport and purchasing can be developed according to the criticality of the parts.

The maintainability of the 'classification model' is high. Any changes in the company or on the market through which other factors may become important can easily be put in de hierarchy and new relative weights can be calculated. In general, restructuring of the hierarchical model will not be necessary very often, because it is highly unlikely that management differs its view on relevant criteria frequently.
Furthermore, by periodically running the (automated) classification the criticality of the parts remains up to date. Rerunning the classification will be necessary as parts 'develop'; the phase in the life cycle changes, customer contracts change, demand patterns change etc.

Next to this the introduction of new products, and therefore new spare parts, does not give any problems. New parts are simply analyzed with respect to the relevant criteria and alternatives and within no time it is clear whether the part is Vital, Essential, or Desirable and the way the part has to be dealt with is known.

Moreover, the VED model can be used for achieving a more integrated stocking strategy.
Although the ESSC advises the countries on their logistics to enable a better use of the European stock, the countries are free to purchase spare parts whenever they want as they are autonomous with regard to their logistic operations. The countries remain the owner of their stock and are responsible for inventory costs and the related service performance. Due to this Digital does not have a real integrated stocking strategy.
A VED model could be useful for achieving improved integration. For example it could be decided to stock vital parts in Nijmegen as well as in every SSP, while desirable parts are stocked centrally or are not stocked at all.

4.3 Concluding remarks

The great advantage of this classification is that management has insight in and can classify the parts according to various properties which are most relevant to them.
Systematic criticality evaluation is the key to effective control of spare parts inventory systems. The Analytic Hierarchy Process provides a good help for the evaluation.
The resulting VED model is a framework for the management which:

- can cover the total menu of spare parts;
- include the most relevant criteria and alternatives with respect to the spare parts business;
- provide management to define 'class-made' procedures and activities with respect to the stocking strategy;
- is easy to understand and easily applicable by means of automation;
- has high maintainability (if necessary due to market changes or changed view on relevant criteria);
- can easily be extended with new (introduced) spare parts;
- can improve the integration of the stocking strategy.

5 VED at Digital

5.1 Introduction

In the previous chapter it is stated that before coming to any conclusion about the level of stock of an individual part, it is important to decide on the importance of the part for the service process. Therefore the best advice is to group parts into categories that reflect their importance to the service process, and to establish appropriate levels of control over each category. The VED analysis, proposed as being a good method for grouping parts, however, has one drawback: grouping the parts is a difficult task, which is often accomplished using subjective judgments. To overcome this disadvantage AHP was proposed, as being a systematic procedure which helps evaluating the criticality of spare parts.
At first sight the VED model combined with AHP seemed to be in accordance with Digital's wishes with respect to automation, maintainability and the ability to cover the total menu of spare parts.
However, Digital did not agree with using AHP in combination with the VED model. First of all Digital thinks AHP is too theoretical. The second, and most important reason, for disagreeing with AHP is the fact that one of the most important criteria, 'service response time', can vary for the same spare part. Due to this, spare parts cannot be uniquely assigned to a particular class.
The service response time depends on the contracts with the customers. Customers can choose the service contract, depending on how much they are willing to pay. Service contracts with short response times are more expensive than contracts with longer response times. Service contracts will be investigated further on in this chapter.
Due to these two reasons no further attempts were made to introduce AHP, although this means that using the VED model or it's principles will be difficult and labour-intensive, because Digital uses approximately 50,000 part numbers.

As written in chapter 3, the assignment is carried out on a part of the business of MCS. This part of the business is the warranty service with regard to Compaq products, which will be described in the next section. In section 5.3 to 5.5 several analyses will be described which are carried out with respect to Compaq spare parts. In section 5.6 a framework for the stocking strategy, based on VED principles, will be proposed, which will be applied to Compaq spare parts in section 5.7.

5.2 Compaq

5.2.1 The business

As mentioned before in chapter 2 the after sales activities are not restricted to Digital products only. A few years ago Digital decided to provide its customers brand independence maintenance. Being a multi-brand service provider MCS was contracted by Compaq to be its 'Authorized Warranty Service Provider' (AWSP).
MCS has been a AWSP for Compaq in Europe since November 1995. This means that MCS has to deliver after sales activities for Compaq products as long as Compaq gives warranty on its products.
Next to that MCS also provides service for Compaq products of which the warranty has expired. This part is called the handling of 'non-warranty calls'. Last but not least it is also possible that

MCS has its own service contracts with customers concerning Compaq products. Therefore, a service-call can be a warranty-call and a contract-call at the same time.
In case of a breakdown a customer calls to a national call desk. The call desk checks the kind of system the customer uses, verifies whether or not the warranty for the system has expired and, frequently, determines the kind of service contract MCS has with the customer .
Furthermore the call desk has to screen the call in order to determine the spare parts a service engineer might need at the customer's to repair the system.

The warranty service is devided into five segments. Each spare part is assigned to one segment. Compaq has assigned standard service obligations (response times) to each segment. In case of a failure MCS has to deliver service within that response time.
The segments and the service obligations are:

- Servers (S): Next Business Day (NBD);
- Desktop Business (D): 2 Business Days (2BD);
- Desktop Consumer (DC): 5 Business Days (5BD) (except for England: 2 BD);
- Portables (P): 5 Business Days (5BD);
- Peripherals (PR): 5 Business Days (5BD).

Customers can upgrade the service obligation by paying a certain amount of money, whereby for example a 2BD obligation can be upgraded to a NBD obligation. This also hampers the assignment of parts to certain classes with respect to the service response time.
Compaq uses a bonus system for NBD and 2BD obligations. This means that when MCS performs proper service within the fixed response times Compaq pays an extra bonus in addition to the usual allowance for wages, traveling and profit.
It should be noticed that when a service call is a warranty-call *and* contract-call at the same time the contract-response time, which is almost always shorter than the service obligations defined by Compaq, overrules the warranty-response time.

5.2.2 The menu

The assortment of Compaq exists of approximately 10,000 partnumbers, of which MCS uses about 4,500 partnumbers. By means of a direct connection with the Compaq database MCS obtains part number data on a daily bases. This way MCS always uses the most recent data.
In January '97 approximately 1,900 part numbers are *active*. A part number is called active when there has been demand for that part since November 1995 or when stock is kept for that part.

5.2.3 The goodflow

Compaq only uses Nijmegen for contact with MCS. All communication and information flow via Nijmegen. The physical goodflow, on the contrary, does not flow via Nijmegen. Basically, the parts are directly shipped from the Compaq warehouses or factory to the MCS stocking points.
In general, the supply chain in the countries exists of two echelons. Each country has a central stocking location, called branch, and one or more sub locations, called sites.
Although Nijmegen (ESSC) is no part of the physical goodflow, Nijmegen is the owner of the stock in the countries. Ordering new parts and paying bills is carried out by Nijmegen. All this is called the 'One Inventory Holding Concept'.

Figure 7 depicts the goodflows and flows of information.

The average lead time between the moment that a branch or site orders a part at Nijmegen and the moment that the part is delivered by Compaq at the branch or site is 1 day. It's important to notice that this performance of Compaq is better than the lead-times agreed upon in the alliance between Compaq and MCS.
Defective spare parts are taken back to the branch or site by the engineer and from there shipped back to Erskine, Scotland. The transport of good and defective spare parts is taken care of by UPS, for which Compaq has to pay.

In case the warranty of the returned defective spare parts is not expired MCS receives 100% credit for the parts. This means that MCS receives the purchase price of the parts. Defective spares which do not fall within the alliance, for example parts of which the warranty has expired, cannot be sent back to Erskine and so Nijmegen remains the owner of the (defective) parts.

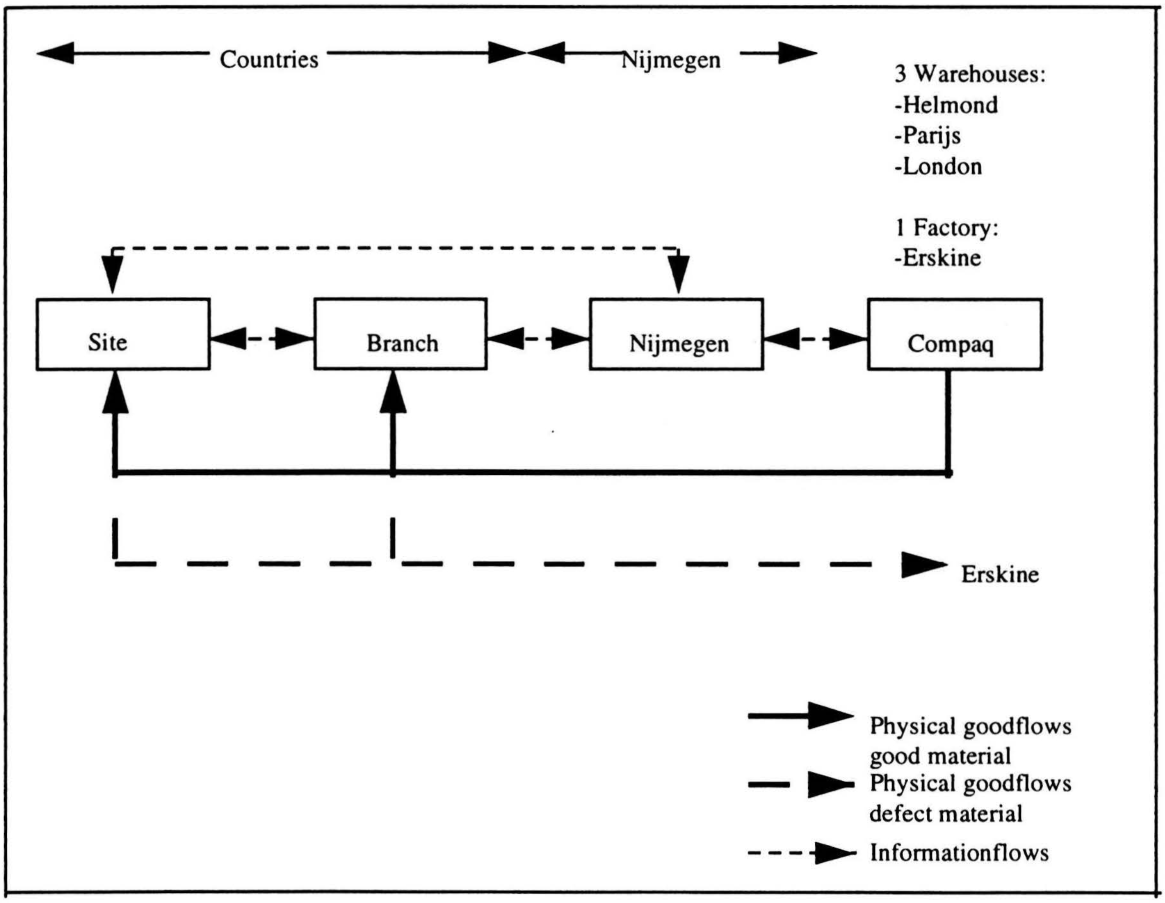

Figure 7 Good- and information flows in the Compaq environment

Nijmegen thinks there is to much stock (excess) of Compaq parts in the countries. Excess is defined as the amount of stock that exceeds the Target Stock Levels (TSL). Excess is caused by various factors:

- Call-center: When a call is screened most of the time it is not exactly clear what part is needed to repair the system. Therefore the call desk often 'orders' more parts. In case these parts are not available from stock they will be ordered via Nijmegen at Compaq. Finally an engineer visits a customer with one or more parts. Parts that were not needed to repair the system are taken back to the branch or site, but cannot be returned to Compaq. So the screening performance of the call desk directly influences the amount of excess.

- Loan: Parts taken by an engineer essentially are on stock, but are not available for other calls. This stock is called 'on loan'. Beforehand it is not clear which parts will return unused. Parts can be on loan for a maximum of three days. However, many times this term is exceeded, through which the branches or sites are forced to order new parts when calls demand the same parts. When parts on loan return unused and new parts have been ordered excess arises.
- Planning: Each country decides whether or not to keep stock for particular parts. When countries stock parts a TSL is determined. In case of changes in the demand pattern of stocked parts or when the demand falls off, the TSL will decrease. At that moment excess arises.

To decrease excess, Nijmegen is allowed to return 10% of the stock value to Compaq once per year for the next four years. After four years, at the end of the present contract, Nijmegen can return 50% of the stock value.

5.2.4 Order process

Most of the time the branches will order at Nijmegen. The part number menu is devided in a 'planned menu' and a 'sourced menu'. For parts that belong to the planned menu a TSL is determined. The TSLs are determined based on (expected) demand figures, just like the TSLs for Digital parts.
When a part is used the stock level drops below the TSL and a replenishment order is automatically placed by the branch at Nijmegen. This process is called 'Consumption Driven Replenishment' (CDR).
Parts from the sourced menu are not kept on stock, but are ordered at the moment they are needed. This is called 'Direct Order Transmission'.
Usually the sites order at the branches. However, when a part is not on stock at the site nor at the branch, the site will order directly at Nijmegen.

5.3 ABC-XYZ classification

In general MCS does not want to keep stock for every part of the assortment. This also counts for the Compaq assortment. Parts which are rarely used should not be stocked, but should be ordered at vendors the moment they are being asked for. Not stocking all parts, directly influences the overall fill-rate that can be reached. The fill-rate is defined as the percentage of orders that can be delivered directly from the shelf. The decision not to stock a certain part of the assortment can be based on the Pareto-analysis. Usually the Pareto-analysis is performed on the value-usage of products. However in a service environment not only the value-usage is important, but also the usage in pieces is important. In other words, a part worth $1000 with a consumption of 50 pieces per month can be of the same importance as a part worth $10 with a consumption of 50 pieces. Both parts can be critical for the service process and therefore both parts can add to customer satisfaction in the same way.
Therefore the Pareto-analysis with the classic A, B and C products has been extended with X, Y and Z products. Products, or in this case spare parts, are classified as A, B or C parts according to

their dollar-usage and classified as X, Y or Z parts according to their usage in pieces. This results in parts classified as AX, AY, AZ, BX, ..., or CZ parts.

The demand for 1886 Compaq spare parts over a period of six months (August '96 - January '97) has been analyzed. The total demand in the six month period amounts 32,823 pieces. The total value of this demand is $M 16.8. Although all 1886 parts are called active parts, demand only occurred on 1307 parts.
Figure 8 and figure 9 respectively depict the Pareto-analysis in dollars and in pieces.

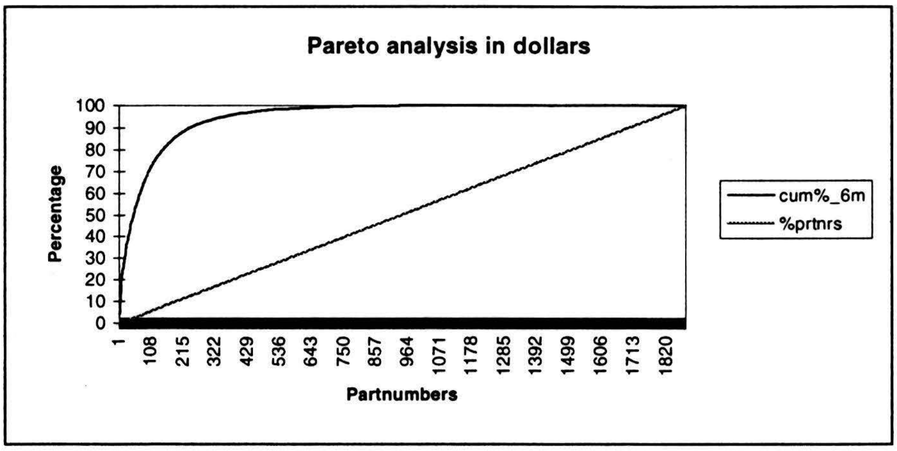

Figure 8 Pareto-analysis in dollars

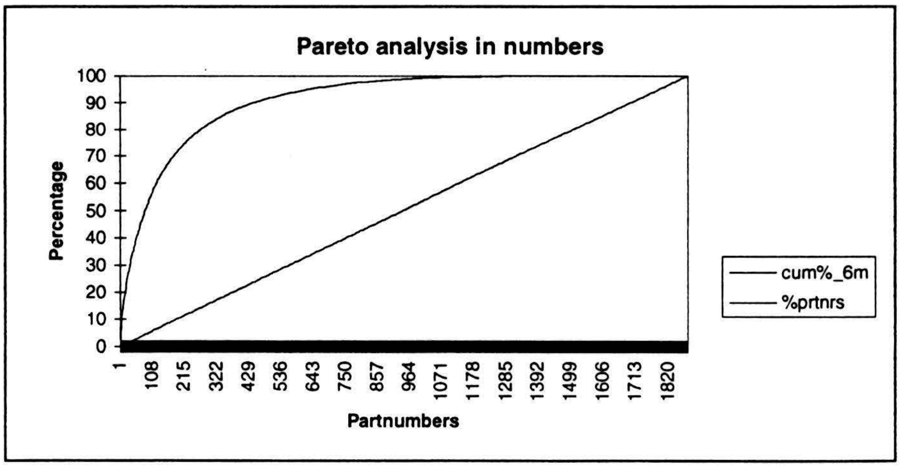

Figure 9 Pareto-analysis in pieces

Figure 8 shows that 95% of the total consumption in dollars is related to 18.5% of the partnumbers and 99% of the consumption in dollars is related to 33.1% of the partnumbers.
With respect to the consumption in pieces these figures are: 95% of the consumption in pieces is related to 33.5% of the partnumbers and 99% of the consumption in pieces is related to 53.0% of the partnumbers.

Both graphs depict that 100% of the consumption is related to 69.3% of the partnumbers, as for 579 parts there was no consumption during the six month period.

A combination of the two graphs results in the following table. Horizontally the classes A, B and C and vertically the classes X, Y and Z are depicted. Along each axis the class borders are 90%, 99% and 100%.
These borders are more or less arbitrarily chosen. They are chosen to show the influence of not stocking a certain part of the assortment. Parts without any consumption in the six month period are assigned to class FF.
The class border between X and Y corresponds with a European consumption of 12 pieces in 6 months. The class border between Y and Z corresponds with a consumption of 2 pieces in 6 months. The 448 parts of the class X are analyzed in more detail in appendix 7.

	$-value			
#-value	A (0-90%)	B (90%-99%)	C (99%-100%)	
X (0%-90%)				Totals
Prtnrs.	228	151	69	448
Consump.(#)	20862	6665	2024	29551
Consump.($)	14940508	680789	34960	15656257
Y (90%-99%)				
Prtnrs.	12	207	332	551
Consump.(#)	100	1253	1591	2944
Consump.($)	208575	779767	93623	1081965
Z (99%-100%)				
Prtnrs.	0	27	281	308
Consump.(#)	0	27	301	328
Consump.($)	0	45465	39149	84614
Totals				FF (0%)
Prtnrs.	240	385	682	579
Consump.(#)	20962	7945	3916	
Consump.($)	15149083	1506021	167732	

Table 3 ABC-XYZ classification

The table shows that when MCS wants to stock parts to cover 99% of the consumption in dollars first of all 625 partnumbers (240+385) have to be stocked. To cover 99% of the consumption in pieces 999 (448+551) partnumbers have to be stocked.
With respect to the customer service the consumption in pieces is considered to be more important than the consumption in dollars, because also a cheap part could cause a serious breakdown at a customer. So when MCS chooses to stock only a part of the assortment the choice should be based on the consumption in pieces.
So, when considering whether or not to stock a part, the first selection of spare parts can be based on that part of the assortment that covers 99% of the consumption in pieces. As written before the limit of 99% is arbitrarily chosen.

The 999 parts for which it is decided to keep them (some how) on stock cover 99.5% of the consumption in dollars. It should be noticed that nothing has been decided about how and where to stock those 999 parts yet. It has only been decided that those parts could be stocked. It also doesn't say anything about the final customer service, because this depends on the way the stock for these parts is controlled. Maybe it's better to say that when the limit is set to 99% of the consumption in pieces the maximum fill rate is 99%, and that it is known that parts from the classes AZ, BZ and CZ (and FF) will not be stocked. These classes contain 887 parts.

Thus, the first selection is based on consumption figures, the same figures nowadays used by Digital to determine the stocking strategy. However, the goal is to investigate the possibilities of implementing the VED model or it's principles into the stocking strategy and therefore to find some criteria which are appropriate for a VED model. The next section will deal with these criteria (or factors).
Already mentioned in section 5.1 as one of the most important factors is the 'service response time'. Although it is expected that this factor is too complex for using in the VED model, due to the various response times per spare part, it is desirable to investigate the response times. For this investigation it was necessary to focus on individual spare parts. Therefore the next section will also deal with a selection of some spare parts.

5.4 VED-factors and a selection of spare parts

With respect to the choice made in the previous section only parts from the classes AX, AY, BX, BY, CX and CY will be selected. Furthermore the selection will be based on certain *factors with respect to the VED-analysis*. As written before, in the service business not only the demand patterns are important when making decisions about stock levels for individual parts. In general the emphasis has to be on criticality of spare parts. Based on criticality spare parts can be classified as vital, essential or desirable for the service process and appropriate levels of control can be established over the different classes.
The factors used here are:

1. product family (service response time);
2. functionality;
3. (repairability).

1.
Each Compaq part is assigned to a certain family. One of the properties of those families is the service response time. In case of a failure of a certain part, MCS has to deliver service within that response time. (See also sub-section 5.2.1).
The families and the response times are:

- Servers (code S): Next business Day;
- Desktop Business (code D): 2 Business Days;
- Desktop Consumer (code DC): 5 Business Days (except for England: 2 Business Days);
- Portables (code P): 5 Business Days;
- Peripherals (code PR): 5 Business Days.

(Again it should be noticed that the foregoing refers to the basic response times. Contract-response times can overrule the warranty-response times. The influence of the contracts will be dealt with further on in this chapter).

With respect to the selection of parts it is decided to take parts from the families S, D and P. In this way all warranty-response times are represented.
On the average 18% op the partnumbers is a 'Server' part, 22% is a 'Desktop Business' part and 30% is a 'Portables' part.

2.
Next to other characteristics Compaq also differentiates it's parts as being 'functional' or 'cosmetic'. Functional means that when a part breaks down also the system to which it belongs breaks down. On the contrary, a failure of a cosmetic part does not directly influence the operation of the system to which it belongs.
It is important to notice that Digital *does not* assign this characteristic to its own spare parts!
The biggest part of the repairable spares are functional (± 98%). With respect to the consumable spares 52% is functional and 48% is cosmetic.
It is decided to select a functional and a cosmetic part for every combination of a repairable part with a family code and for every combination of a consumable part with a family code.

3.
As written in section 2.4 spare parts can be divided into two categories:
-*Repairables*: spare parts that are technically and economically repairable. These parts are swapped for a new one and sent to a repair center.
-*Consumables*: spare parts that are technically and/or economically not repairable. These parts will be scrapped after failure instead of being repaired.

43% of the assortment is repairable. The consumption on repairables amounts 24,450 pieces, which is approximately 75% of the total consumption in pieces. When the consumption is expressed in dollars the share of repairables is even bigger: $16,283,237; that is about 97% of the total consumption in dollars.
Repairability is written between brackets, because it is not considered to be a factor that really determines whether a part is vital, essential or desirable for the service process. However, this factor has been chosen because repairables and consumables both have their own supply chain characteristics. Repairables return after failure (and repair) into the supply chain and consumables go one way to the supply chain and are scrapped after failure.

The selection of spare parts is summarized in table 4.

Repairables					
Family					
S (<24h)	**D** (2BD)	**P** (5BD)	Func./Cosmet.[1)]	Partnumber	Class
x	0	0	1	199643001	AX
x	0	0	2	142261001	((CZ): 1 part)
0	x	0	1	160788201	AX
0	x	0	2	148290002	BY
0	0	x	1	213546001	AX
0	0	x	2	144850003	BX

1) Functional = 1; Cosmetic = 2

Table 4 Selection of spare parts

Consumables					
Family					
S (<24h)	**D** (2BD)	**P** (5BD)	Func./Cosmet.[1)]	Partnumber	Class
x	0	0	1	169052001	BX
x	0	0	2	106854001	CX
0	x	0	1	141189001	BX
0	x	0	2	173066001	BX
0	0	x	1	213564003	AX
0	0	x	2	147050001	BX

1) Functional = 1; Cosmetic = 2

Table 4 Selection of spare parts

Bottom line, twelve partnumbers have been selected. It is important to notice that this are 'Compaq partnumbers'. Each Compaq partnumber also has a 'Digital partnumber'. The partnumber descriptions and the assigned Digital partnumbers can be found in appendix 8.
These parts represent the variety of spares in the total menu of Compaq partnumbers, with respect to the factors that are related to the principles of the VED analysis. The table shows that the selection is based on 'repairabilty', 'service response time' and 'functionality'. Factors like *consumption* and *price* were not used here to select the parts, since *consumption* was already used with respect to the ABC-XYZ analysis and in section 5.3 it has been concluded that the *price* must be inferior to the consumption (in pieces).
However, these factors can be important with respect to the distribution strategy and therefore they will be dealt with further on in this report. The table in appendix 9 depicts the values of the parts with respect to these factors.
Also the factors *life cycle* and *purchase lead-time*, mentioned in section 4.2, were not used for the selection of the spare parts. The reason for this is the inability to define the stage in the life cycle and the fact that almost all parts can be delivered by Compaq within 1 day, throughout Europe (sub-section 5.2.3).

At the end of section 5.3 it is mentioned that no parts from the classes AZ, BZ and CZ would be selected. Nevertheless, the second part in table 4 is a part from class CZ. This 'selection' is caused by the fact that there was just one part with the characteristics: *repairable*, *family S* and *cosmetic*. In the remainder of this chapter this part will be neglected.

As written at the end of section 5.3 the selection of spare parts is necessary for the investigation of service contracts, which MCS has on top of the warranty service for Compaq products.
Furthermore, to be able to investigate service contracts it is necessary to focus on a particular country, as each country contracts it's own customers. Therefore, the next section describes an investigation of contracts per spare part per country (the Netherlands).

5.5 Contracts per spare part per country

First of all the European demand for the selected spare parts and the demand per spare part per country is analyzed. This is done in order to find out where the bigger part of the business is located.
Unfortunately consumption data per country were only available over a four month period (October '96 - January '97).

First the total European consumption and the consumption per country for all spare parts was analyzed. The total European consumption in the four month period amounted 23,161 pieces. Appendix 10 depicts the consumption per country. In all countries, except for the United Kingdom, the consumption is based on both warranty and contract calls. The consumption in the UK (depicted in appendix 10) is based only on warranty calls.

The mayor part of the business is located in England (41%), although *only warranty* consumption is included. 75% of the parts are consumed in only four countries: England, Switzerland, the Netherlands and Germany. Although consumption data per country was only available over a four month period this conclusion was confirmed by several people who are operating in the Compaq environment.
Next the consumption of the selected parts per country was analyzed. This analysis also showed that the mayor part of the consumption is concentrated in the UK, Switzerland, the Netherlands and Germany.
For these four countries consumption figures (over four months) per spare part per country are depicted in appendix 11. Appendix 12 depicts the consumption figures per month.

Initially it was planned to investigate contracts with respect to the selected parts in all four countries mentioned above. In order to be able to investigate the number of contracts and the properties of the contracts, partnumbers should, in one way or another, be linked to contracts. To get the proper information appeared to be very difficult and time consuming and was only possible, due to lack of time, in the Netherlands. Even that information is incomplete.
First of all contracts refer to products and not to spare parts. Therefore the products had to be determined in which the selected spare parts occur. This was done by means of the Recommended Spares Lists (RSLs), which are based on Digital partnumbers. The Compaq partnumbers and the corresponding Digital partnumbers can be found in appendix 8. A partnumber can have an one-to-many relationship with products. In other words, a part can occur on more than one RSL.
After determining the proper products the 'contracted' installed base per product was determined. As written before, only the installed base in the Netherlands could be traced. Moreover, for only nine partnumbers the installed base could be traced.

Table 5 depicts the selected partnumbers, the number of models in which the parts occur, the number of contracted models and the contracted installed base for that particular group of models. The contracted installed base indicates the *number of* products for which Digital has contracts. Nothing is written about the characteristics of the contracts, like response times, yet.

The information in table 5 means: "partnumber 213564003 occurs in 7 models, MCS has contracts for two models and bottom line MCS has contracts with customers for 20 'pieces' ". It must be noticed that not all contracts with customers are specified to product level. This sometimes occurs when Digital has 'site wide' contracts, which means that every product of every brand at that customer is being serviced by Digital. In case of an insufficient inventarization of the installed base at that particular customer, the product-contract database will be incomplete. Therefore it's most likely that the data presented in table 5 is not complete, but it's the best result that can be reached.

The next step is to analyze the contracts for the products mentioned in table 5. The analysis of the contracts focuses on the response times. First of all the contract information was withdrawn from the information system. Unfortunately, it was not possible to withdraw contract information of every contracted model. Appendix 13 depicts the number of contracted models of which information was found.

Partnumber	Number of models	Number of contracted models	Total number of contracted products
Repairables			
199643001 *neglected*	23	15	231
160788201 148290002	63 not available	23 not available	1175 not available
213546001 144850003	7 1	2 1	20 1
Consumables			
169052001 106854001	54 not available	35 not available	272 not available
141189001 173066001	92 71	50 29	246 119
213564003 147050001	7 1	2 1	20 4

Table 5 Partnumber, models and number of contracted products in the **Netherlands**

The response times in the contracts can be divided into four categories: '2 hours', '4 hours', '8 hours' and 'next day'.
Almost 90% of the contracted products (of which information could be found) have a response time of 4 hours or less. 26% of those products are related to 'Server' (S) spare parts (partnumbers 199643001 and 169052001), with a standard (Compaq) warranty-response time of 1 day (NBD). 61% of those products are related to 'Desktop' (D) spare parts (partnumbers 160788201, 141189001 and 173066001), with a standard (Compaq) warranty-response time of 2 business days (2BD). The foregoing shows that MCS considerably shortens the response times by closing service contracts with customers.

Moreover, the foregoing analysis shows that the service response time indeed is a too complex factor for using in the VED model. It is not possible to assign spare parts to individual classes with respect to the response time, because one spare part can be represented by different models for which different response times can be contracted. This problem could be solved if Digital defines standard response times for spare parts instead of having contracts for models (products), which are, for the bigger part, determined by the customers. However, at the moment assigning spare parts according to response times is not possible.
The consequence of this is that apart from the consumption figures, used for the ABC-XYZ analysis, there only remain two factors of the three VED-factors that were used in section 5.4.
Summarizing, these remaining factors are:

- consumption (ABC-XYZ);
- functionality;
- (repairability).

In section 5.4 it has already been mentioned that 'repairability' is no real VED-factor and that it has only been chosen to emphasize the need for special attention to the different supply chain characteristics of repairables and consumables.
In the next section the two remaining factors will be used to define a framework for the stocking strategy. Consequently this framework will consist of one VED-factor and the factor 'consumption'.

5.6 A framework for the stocking strategy: which spare parts have to be stocked?

In section 5.5 it has been concluded that apart from consumption, there only remain one real VED-factor for determining a framework for the stocking strategy. At first notice the VED model is developed to assign parts in three classes: vital, essential and desirable. When considering the factor 'functionality', this factor only has two alternatives. Either a part is functional, or it is cosmetic.
When a functional part breaks down also the system to which it belongs breaks down. It is difficult to determine how serious such a breakdown will be in terms of loss, when no stock is available. Among other things the loss for the customer depends on the application of the particular system. The availability of substitutes can limit the loss for a particular user. The loss for MCS depends on the kind of contract MCS has with it's customer (response time, penalty clause). As it is hard to distinguish between functional parts based on (possible) loss in case of a breakdown, all functional parts will be assigned to one class.
A failure of a cosmetic part does not directly influence the operation of the system to which it belongs. Because the system will not break down, the user or the process is able to continue and no additional loss will be inflicted. Consequently, there is no need to distinguish between different kinds of cosmetic parts in terms of loss.
The foregoing means that parts will be assigned to only two classes. In order to use the terminology of the VED model the class names have to be determined.

Considering the general definitions of a vital and an essential part in case of the VED analysis, a functional part can be considered as a vital as well as an essential part. For, the definition of a vital part is: a part, which, if not on stock, could result in *huge losses* due to non-availability of the equipment needing the spare. The definition of an essential part is: a part, which, if not on stock, could result in *moderate losses*. Although it is hard to determine the loss in case a functional part breaks down, the term *huge* will not be appropriate most of the time. The term *moderate* losses seems to be more appropriate in case a functional part breaks down and no stock is available at that moment. Therefore, all functional parts will be to assigned to the class: "Essential parts" (E).
Because a failure of a cosmetic part does not break down the system to which it belongs, cosmetic parts can be assigned to the less important or less urgent class: "Desirable parts" (D).
This classification results in one axis of the framework for the stocking strategy.

The second axis will be based on the other factor mentioned at the end of section 5.5: consumption. In section 5.3 it has already been mentioned that, with respect to the customer service (whether or not to stock parts), the consumption in pieces is considered to be more important than the consumption in dollars, because also a cheap part could cause a serious breakdown at a customer. With respect to the ABC-XYZ analysis, performed in section 5.3, this means that from now on the focus will be on the classification of X-, Y- or Z parts, where class X parts are fast moving parts, class Z parts are slow moving parts and class Y parts are in between the two former classes.
This second classification completes the framework, which is depicted in figure 10.

The framework consists of six segments. Each segment represents a particular group of spare parts. The segment XE for example represents all fast moving, functional parts. It depends on the definition of fast moving parts how big this group of parts will be. The class borders between the classes X and Y, and Y and Z can be chosen arbitrarily. In section 5.3 the borders 90% and 99% were chosen. However, also 80% and 95% could be an acceptable choice. Segment ZD represents all slow moving, cosmetic parts.

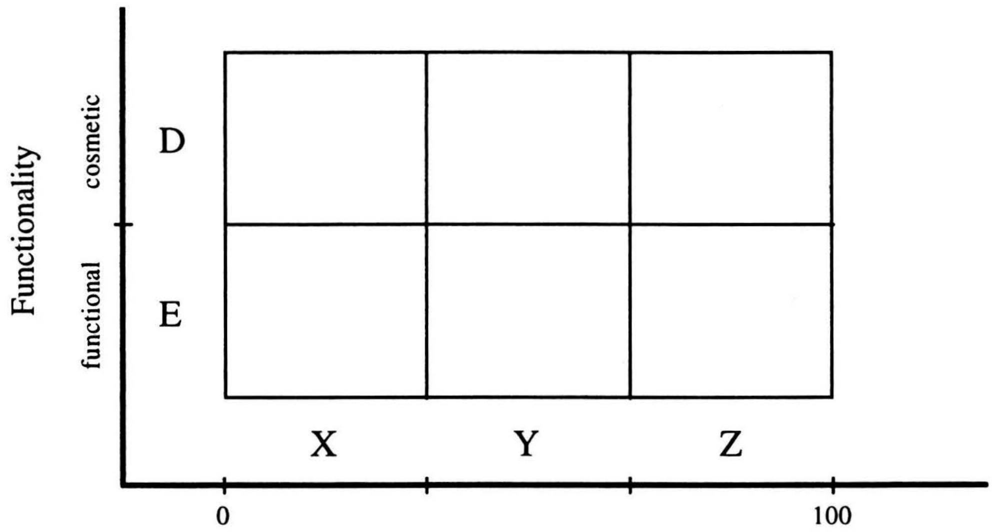

Figure 10 Framework for the stocking strategy: which parts have to be stocked?

Each segment (or group of segments) requires a different approach with respect to the stocking strategy.
It is important to notice that the stocking strategies for the separate segments for the bigger part depend on decisions to be made by Digital. For example it could be decided that cosmetic parts will not be stocked at all. From the systems point of view this is possible, because failures of cosmetic parts will not influence the operation of the systems. However, when this is decided, the service contracts with customers should mention that cosmetic parts are not included with respect to service response times. Otherwise, customers can force MCS, on penalty of a fine, to deliver service on cosmetic parts within the contracted response time (which are often very short).
However, it is also possible that from the physical distribution point of view it is better to stock fast moving, cosmetic parts to decrease transport costs. Physical distribution covers the areas of inventory control, warehousing and external transport (Van Goor *et al.* (1994)). Those parts can be shipped to the warehouses by consolidated transport, which can be cheaper than shipping single cosmetic parts, whenever they are needed. Whatever the strategy will be, MCS has to decide about the alternatives and of course supporting trade-off calculations might be necessary.

In section 5.4 it was already mentioned that Digital does not differentiate its spare parts as being functional or cosmetic. Application of the framework therefore depends on whether Digital is willing to assign spare parts according to the factor 'functionality'. However, at this moment it is only possible to apply the framework to Compaq spare parts. This application has been described in the next section.

5.7 Application of the framework for Compaq spare parts

Again the demand for the 1886 Compaq spare parts during the period August '96 - January '97 has been used. The total demand during these six months amounts 32,823 pieces. Although all 1886 parts are called 'active parts', demand only occurred on 1307 partnumbers.
In section 5.3 the class borders along the axis of the ABC-XYZ classification were chosen arbitrarily as 90% and 99%. This choice has also been made for the X-Y-Z axis of the framework. In this application the parts without any consumption are not assigned to class FF, as was done in section 5.3, but are assigned to class Z; the class for slow (to very slow) moving parts. Figure 11 depicts the distribution of the parts among the different segments.

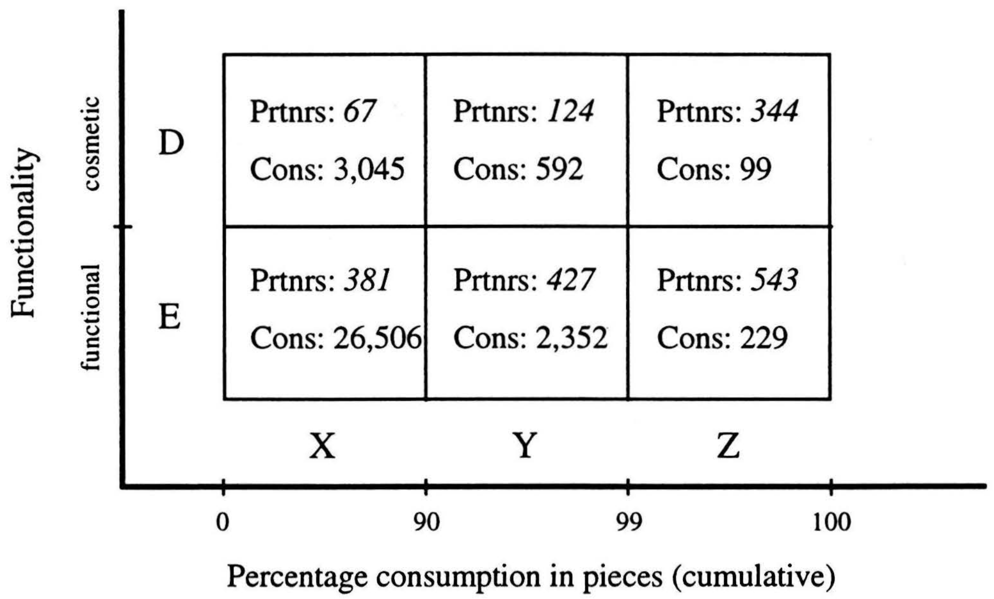

Figure 11 Framework applied to Compaq spare parts

Next to the number of parts per segment also the total consumption in pieces of those parts during the period of six months is depicted.

In general MCS does not want to keep stock for every part of the assortment. This also counts for the Compaq assortment. Parts which are rarely used should not be stocked, but should be ordered at vendors the moment they are being asked for. Not stocking all parts, directly influences the overall fill-rate that can be reached. The fill-rate is defined as the percentage of orders that can be delivered directly from the shelf.
Figure 11 shows that when MCS wants to stock parts to cover 99% of the consumption in pieces, initially 999 partnumbers (381+67+427+124) will have to be stocked. In that case, parts from class Z will not be stocked. In January '97 approximately $ 483,000 was invested for stocking parts from class Z. These investments could become savings, but could also be used to invest in parts which belong to the classes X and Y, to achieve a higher fill-rate for those parts.
It is important to notice that the next decision should be about how and where to stock those 999 partnumbers. Just decide to stock 999 partnumbers doesn't say anything about the final customer service, because this depends on the way the stock for these parts is controlled.

In the same way figure 11 explains the consequences of not stocking cosmetic parts. When MCS chooses to stock only functional parts, the maximum overall fill-rate will be approximately 89% ('consumption of functional parts' / 32,823). As written before, in this case the customers should be informed about the cosmetic parts not being included in the contracts with respect to the service response time. With respect to January '97, not stocking cosmetic parts could result in a decrease of approximately $ 128,000 invested in stock for spare parts.

Another approach is to stock parts of the segments XE, XD and YE. This means that no slow moving parts (class Z) will be stocked nor cosmetic parts with a (considerably) low consumption (YD). Using this approach, 875 partnumbers should be stocked and the maximum overall fill-rate will be 97% ((26,506+2,352+3,045) / 32,823). In January '97 approximately $ 535,000 were invested to stock parts of the segments YD, ZE and ZD. Again, these investments could become savings, or could be invested to increase the service for the fast moving parts.
Several alternatives are possible within this strategy. For example parts of segment XE could be stocked in every branch and site, and parts of the segments YE and XD could be stocked centrally in Nijmegen or centrally in the countries (branches). The next chapter will deal with the kind of decisions (supported by calculations) that have to be made after it has been decided which partnumbers (segments) will be stocked.

Expressed as a percentage of the total investments in stock for Compaq parts in January '97 ($M 4.97) the possible savings are not very high. Stocking parts of the classes X and Y only, initially can decrease investments by 9.7%. Not stocking cosmetic parts, initially can save 2.6%. The last approach, described in the paragraph above, initially can decrease investments in stock by 10.8%.
However, the business for Compaq only concerns 1886 partnumbers. As described before, the total business of Digital concerns much more partnumbers, so the possible savings (decreases of investments), expressed in absolute numbers, could be very high. Especially, when the slow moving and cosmetic parts will not be stocked.
The only thing that should be done to make this kind of an approach possible, is to differentiate all parts as functional or cosmetic and to make sure that cosmetic parts are not included in the contracts with respect to the response times.

The framework in figure 11 does not distinguish between repairables and consumables. Of course it is possible to apply the framework separately to both types of spare parts. However, with respect to the Compaq parts it appeared that approximately 98% of the repairables are functional parts. So, creating two frameworks, distinguishing between both types of parts, was omitted.
Nevertheless, when deciding about the stocking strategy in more detail it is important to keep in mind that repairable- and consumable spare parts both have their own supply chain characteristics. Repairables return after failure (and repair) into the supply chain, but consumables go one way through the supply chain.
Sherbrooke (1992) also describes the differences between repairables and consumables and he concludes that repairables are more important in the spare parts business than consumables and therefore should get more attention.
Sherbrooke concludes that:

- most of the time the availability of systems is dominated by repairable items;
- repairables tend to be more expensive;
- the demand for any particular repairable item tends to be low;
- on a group the repairable items comprise the largest part of the spares business;

- repairable items tend to have longer lead-times than consumables.

For the bigger part, these conclusions also count for the Compaq spare parts used by Digital. The availability of computer systems is dominated (or even determined) by functional parts. 1351 spare parts of the 1886 Compaq parts that were investigated are functional. 60% of those parts is repairable.
The average price of a repairable Compaq part is $ 717, where the average price of a consumable part amounts $ 78. Although the average demand for a repairable item is relatively low (30 pieces per six months), the average demand for consumables is even lower (8 pieces per six months). Repairable Compaq spares indeed comprise the largest part of the spares business, as the demand for these parts amounts approximately 75% of the total demand for spares. Although the lead-times of repairable and consumable spare parts were not investigated extensively, it is confirmed that repair lead-times are longer than purchase lead-times.

To conclude this chapter, figure 12 depicts the determination of the stocking strategy when Digital differentiates parts as functional or cosmetic. This figure refers to figure 5, section 3.2, where the stocking strategy was only based on the consumption profile.

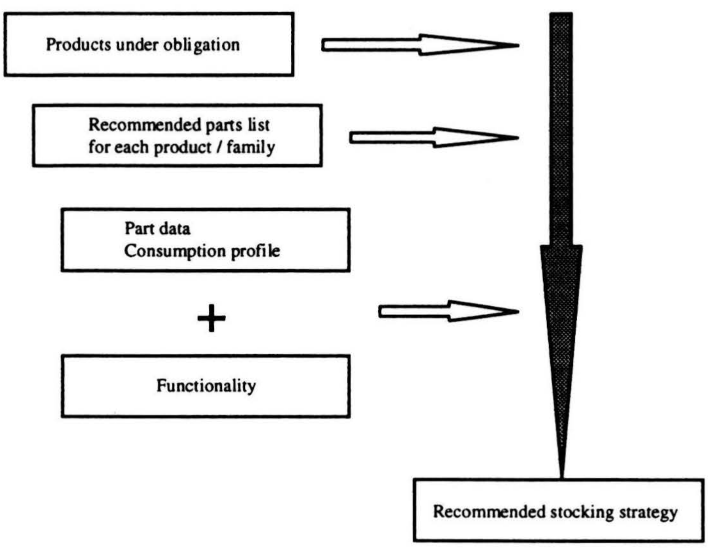

Figure 12 Determination of stocking strategy, including VED principles

The next chapter deals with the decisions (supported by calculations) that have to be made after it has been decided which partnumbers (segments) will be stocked.

6 Quantity and location of stocked spare parts

6.1 Introduction

In section 3.1 it has been described that Digital is interested in two main issues. These issues are:
1. Which parts have to be stocked?;
2. How much stock has to be maintained of those parts and where do they have to be stocked?

In the previous chapter a framework for the stocking strategy has been proposed, which is based on the consumption in pieces and the VED-factor 'functionality'. Application of this framework requires differentiating spare parts as functional or cosmetic and determining class borders by looking at the cumulative proportional consumption in pieces. This results in six segments, for which can be decided separately whether or not to stock parts of a particular segment. So, with the application of the framework the first issue can be solved.
It can be concluded that by deciding which segments of spare parts will be stocked, the maximum fill-rate is determined. However, just decide to stock spare parts does not say anything about the final customer service. Among other things, this depends on the stocked quantities and the location of stocked parts, which is described above as the second issue.

In this chapter an attempt is made to find some answers to this second issue. It has already been described in section 3.3 that conventional inventory control methods, known as SIC, are limited or not applicable to the major part of the assortment. The suitability of these methods decreases with the decrease of the frequency of demand. In could be argued that, due to the application of the framework, low demand spares are left out by deciding not to stock them. However, in case of the Compaq parts, the average demand per part per month in class Y of figure 11, section 5.7, is less than 1. Nevertheless, it is quite thinkable that those parts will be stocked somehow, because otherwise the maximum fill-rate would be 90%. This could be judged as being too low. Likely, the same holds for the remaining spare part assortment of Digital. Therefore, it is expected that still a major part of the spares that will be stocked are low demand spares.

Further research learned that there are sophisticated mathematical models, with complex distribution functions to approximate low demand levels, but these models seemed hard to implement and hard to maintain. Due to this, the calculations described in this chapter are simplified and, from a mathematical point of view, will not give an optimal solution. Nevertheless, the calculations provide insight in the investments necessary to acquire a certain Level Of Service. One of the formulas (section 6.3, formula 1) have been developed in cooperation with Mr. Crowe, mentor of this project at Digital Equipment Parts Center B.V. in Nijmegen.

In contrast with the previous chapter, the next sections will not focus on the 1886 Compaq spare parts, but cover a much bigger part of the business of MCS. This has been decided because the Compaq business (see section 5.2) is not representative with respect to the stocking locations. Compaq spares are only stocked in the countries, whereas, in section 3.4 it has been mentioned that the countries (SSPs) as well as Nijmegen (ESSC) would be taken into account with respect to the determination of an integrated stocking strategy.
Of course this change of focus does not harm the framework that has been described in chapter 5. The framework must be looked upon as an independent tool to decide whether or not to stock particular parts (or segments). After that decision, it has to be determined how much and where

parts have to be stocked to acquire a pre-specified Level Of Service. The argumentation and calculations to support these decisions are described in this chapter.
Because the framework of section 5.6 cannot yet be applied to other than Compaq spare parts, it is assumed that the first question ("which parts have to be stocked?") has already been answered, and that the 30,000 spare parts mentioned in this chapter (section 6.4), must all be stocked somehow.

6.2 A framework for the stocking strategy: how much and where to stock parts?

With respect to the first issue ("which parts have to be stocked?") the consumption in dollars, or in other words the price, was considered to be of less importance than the consumption in pieces. However, when deciding about how much and where to stock parts, the price of a spare part is important. After all, it is undesirable to stock very expensive spare parts in every local warehouse, so if possible, such parts will be stocked centrally in the countries or even centrally in Europe (Nijmegen) and the number of pieces on stock will be kept to a minimum. On the other hand, there will not be much resistance when (considerable numbers of) cheap spare parts are stocked in every local warehouse.

As mentioned in section 6.1 it is expected that, after the application of the framework of section 5.6, still a major part of the spares that will be stocked are low demand spares. Therefore, the characteristic 'usage in pieces' will also be important when deciding about how much and where to stock parts. It is likely that fast moving spare parts are stocked in local warehouses, as large(r) quantities can be shipped by cheap(er) means of transport. On the contrary, slow moving parts will be stocked centrally (to decrease inventory costs) and, when demand occurs, such parts will be shipped to the customer. If necessary, such parts can be shipped by a courier or taxi.

Although both factors are very important, again the most important factor is the time that is allowed to provide customers with spare parts. After all, one of the functions of stock is to uncouple (disconnect) successive processes, which allows the processes to have a certain independent time of execution (Van Goor *et al.* (1994)). In this context the successive processes are replenishment and repair. If the repair process allows spares to arrive within a day after a call, the decision concerning the location of stock will be different from the decision when parts have to be available for repair within several hours.
From previous chapters it is clear that this time depends on the service contracts in which the service response times are defined.

The characteristics mentioned above can be depicted in a framework again (see figure 13).
Along the axes two general classes are defined. Of course this classification is arbitrarily; it is up to Digital to decide how many classes will be defined per characteristic and what the specific class borders will be. However, it is recommended to limit the number of classes per axis, as the number of segments increases rapidly, with the increase of the number of classes. The classification in figure 13 results in 8 segments. For visual support two segments have been emphasized.
Each segment represents a particular group of spare parts. Each segment (or group of segments) requires a different approach with respect to the issue 'how much and where to stock parts?'.

A general stocking strategy for all segments will be discussed here.

Low price and short response time
The segment, representing cheap, *fast moving* spare parts with a short response time, requires parts to be stocked (in large numbers) in local warehouses. Likely, also cheap *slow moving* spare parts with short response times will have to be stocked in local warehouses, but not in the same large numbers as the fast moving parts.

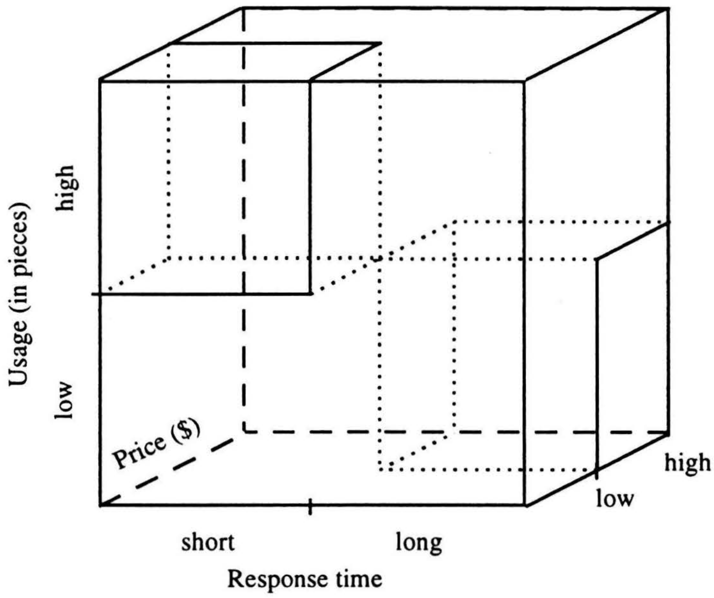

Figure 13 Framework for the stocking strategy: how much and where to stock parts?

Low price and long response time
Spare parts assigned to the two segments with the characteristics 'low price' and 'long response time' should primarily be stocked centrally in the countries or even in Nijmegen. Only for the *fast moving* spare parts inventory costs (which are low for cheap parts) and transport costs could be investigated, in order to determine whether or not local stocking is preferred to central stocking. Local stocking of fast moving spare parts could decrease transport costs, as larger quantities can be shipped by cheap(er) means of transport.

High price and short response time
These two segments require firm management, as stocking parts of these segments is very expensive. Due to the short response time, the parts primarily have to be stocked in local warehouses. Yet, it is not desirable to just stock large numbers of *fast moving*, expensive spare parts, like it was stated for cheap spare parts. So, on the condition that the customer service will be acceptable, the number of pieces on stock have to be kept to a minimum.
For *slow moving* spare parts it might be worthwhile to consider the use of fast, expensive means of transport (taxi), and hence being able to stock these parts centrally in the countries, which decreases the inventory costs.

High price and long response time
Primarily, parts with these characteristics should be stocked centrally. Because of the high price of the parts a central European stock could be preferred to central stock in the countries; especially for *slow movers*. In case of *fast moving* parts the trade-off between transport costs and inventory costs might be in favor of central stocking in the countries instead of stocking in Nijmegen.

In this way an integrated stocking strategy can be determined for all segments or groups of segments. Though, at the moment there is no possibility to assign spare parts to classes according to their response times. Like it has been concluded before, this is caused by the fact that a spare part can be represented by different products for which different response times can be contracted. This problem could be solved if Digital defines standard response times for spare parts instead of having contracts for models (products), which are, for the bigger part, determined by the customers. Due to this impossibility the framework remains conceptual and it will be up to Digital to use the framework and 'fill' the segments with spare parts.

For now only the characteristics 'usage in pieces' and 'price' will be used to provide insight in the investments, necessary to acquire a certain Level Of Service. In section 6.3 an outline of the theory, which is used to calculate the Level Of Service, is described.

6.3 Outline of theory

6.3.1 Level Of Service

In section 3.1 it has been described that Digital wants to know what has to be stocked in order to fulfill a pre-specified Level Of Service. The Level Of Service is defined as: the percentage of demands that can be delivered directly from the shelf in case demand occurs, as experienced by the customers. Neglecting other influences this service level can be seen as the final customer service. In this section the overall Level Of Service, is considered to be composed of two factors:

1. the percentage of total consumption;
2. the fill-rate.

The formula for the overall Level Of Service, used in this chapter is:

$$LOS = \sum_{p=1}^{N} ptc_p * FR_p \qquad (1)$$

where LOS = overall Level Of Service, $0 \leq LOS \leq 100$
p = spare part type (= partnumber), p = 1, 2 , ..., N
ptc = percentage of total consumption, $0 \leq ptc \leq 100$
FR = fill-rate, $0 \leq FR \leq 1$
N = total number of spare part types that have to be stocked

This formula shows that the pre-specified overall LOS, strived for by Digital, depends on the fill-rate of individual spare parts multiplied by their share in the total consumption (in pieces). In the remainder of this chapter this will be called the 'weighted fill-rate'. Hence, it is necessary to determine the stock levels for the spare parts that are required to realize a sufficient fill-rate per spare part. Finally, the sum of all 'weighted fill-rates' has to be equal to or bigger than the pre-specified LOS. The next sub-sections will deal with the two factors of formula 1.

6.3.2 Percentage of total consumption

Based on the figures 'total consumption (in pieces)' and 'consumption per partnumber (in pieces)' the percentage of total consumption per partnumber (ptc_p) can be calculated. It has already been mentioned in section 5.3 that, with respect to the issue whether or not to stock parts, the consumption in pieces is considered to be more important than the consumption in dollars. Therefore, the ptc_p is a good standard with regard to the importance of a part for the service business. From this and from the formula mentioned above, it can be concluded that stocking fast moving parts, and hence delivering these parts directly from the shelf, can contribute more to the customer service than delivering slow moving parts directly from the shelf.
Besides calculating the ptc per part, one can also calculate the ptc for a group of parts (ptc_G).

6.3.3 Fill-rate

The fill-rate is defined as the fraction of demands that is met from stock on the shelf (Sherbrooke (1992)). At first notice this definition looks like the definition of the Level Of Service, but here the sentence "as experienced by the customers" has been left out.
Regarding fill-rate, there will be a fill if there is stock on hand. In other words, there will be a fill if there are one or more parts on the shelf when demand occurs. If the customer demand cannot be met, there are two possibilities: (1) the customer goes away (lost sales); (2) the customer returns at a later time when the stock has been replenished (backorder). In this chapter it is assumed that any demand that cannot be filled from stock on the shelf is backordered.

Sherbrooke (1992) defines the stock level (s) as:

$$\boxed{s = OH + DI - BO} \qquad (2)$$

where s = stock level
OH = number of units of stock on hand
DI = number of units of stock due in from repair or resupply
BO = number of backorders

The stock level, s, is a constant. The other variables are nonnegative random variables. Any change in one of these variables is accompanied by a simultaneous change in another. For example, when a demand occurs, the number due in from repair or resupply increases by one (one-for-one replenishment). If the stock on hand is positive, it is decreased by one; otherwise, the backorders increase by one. In either case the equality is maintained.
When a repair is completed or a new part has arrived from resupply, reducing DI by one, the backorders are reduced by one or, if there are no backorders, OH is increased by one. Again the equality is preserved. The simplicity of the equation mentioned above is due to the fact that the order quantity for the batch size to repair or resupply equals one (see also section 2.6).

In order to calculate the expected fill-rate, the quantities from the stock level (s) and the steady-state probabilities for the number due in (in repair or resupply) have to be estimated.

If the number DI is s-1 or less there will be a fill, because that means there is stock on hand (OH). Whenever the number DI is s or more, there is no stock on hand. Thus, the expected fill-rate, FR(s), can be calculated as:

$$FR(s) = \Pr\{DI = 0\} + \Pr\{DI = 1\} + \ldots + \Pr\{DI = s-1\} = \Pr\{DI \le s-1\} \quad (3)$$

where the Pr{ } terms are the steady-state probabilities for the number of units of stock due in. Among others, Sherbrooke (1992) thinks of them as Poisson probabilities with mean *mT*. The quantity *mT* is calculated by Palm's theorem, which says:

> If demand for an item is a Poisson process with annual mean *m* and if the repair (or resupply) time for each failed unit is independently and identically distributed according to any distribution with mean *T* years, then the steady-state probability distribution for the number of units in repair or resupply has a Poisson distribution with mean *mT*.

Thus the Poisson distribution for the number of units due in (DI) is given by:

$$\Pr\{DI = i\} = \frac{(mT)^i e^{-mT}}{i!} \quad (4)$$

where i = 0, 1, 2, ...
This formula enables the calculation of the expected fill-rate, based on a particular stock level, an average monthly demand, an average resupply time (in months) and the assumption that the demand for the parts is a Poisson process. This will be illustrated by an example.

<u>Example:</u>
Suppose the average demand for a spare part at a particular SSP is a Poisson process with monthly mean 1 and the resupply time for each failed unit is distributed with mean time 1/10 month (3 days). Then the steady-state probability distribution for the number of units due in (DI) (in resupply) has a Poisson distribution with mean 0.1, or

$$\Pr\{DI = i\} = \frac{(0.1)^i e^{-0.1}}{i!} \quad (5)$$

Table 6 depicts the fill-rate in case of different stock levels.

Stock level (s)	Fill-rate = Pr{DI ≤ s-1}	FR(s)
0		0
1	Pr{DI=0}	$e^{-0.1}$ (= 0.905)
2	Pr{DI=0} + Pr{DI=1}	$e^{-0.1} + 0.1e^{-0.1}$ (= 0.995)

Table 6 Calculation of the fill-rate for a single spare part

It is clear that if Digital does not hold stock for this part the expected fill-rate will be 0, because there is no stock on hand (OH).
If the stock level equals 2 in that SSP, Digital will almost always be able to fill a call for this particular spare part.

Then, if the ptc_p of this part equals for example 20% of the total consumption, stocking this part (with s = 2) contributes 20% x 0.995 = 19.9% to the overall Level Of Service (see formula 1).

The calculation of the fill-rate for a group of parts, FR_G, requires the use of an average demand and average repair or resupply time for that group of parts. The average fill-rate for all parts again depends on the stock level (s), but in this case it concerns the average stock level of all parts in that group. Mathematically this calculation is not exact, but it is an approximation of the required stock level for a group of parts. As it is not an exact calculation, it is recommended not to use it for fast moving parts, which can contribute considerably to the Level Of Service, but to only use it for groups of slow(er) moving parts.

The theory mentioned in this section will be used in section 6.4 to develop a spreadsheet which provides insight in the investments necessary to acquire a particular overall Level Of Service. It will become clear that, with the assistance of the spreadsheet, the influence of the service response time on the stocking strategy, although not being a parameter in the spreadsheet, can be shown.

6.4 Level Of Service calculations for 30,000 spare parts

In this section a spreadsheet will be developed which provides insight in the investments necessary to acquire a pre-specified overall Level Of Service.
First the assortment of approximately 30,000 spare parts, for which the fill-rate will be calculated, has been divided into eleven groups according to the European consumption during a period of six months (September 1996 - February 1997). Group 1 contains the fastest moving spare parts and group 11 contains the slowest moving parts (consumption is 0 pieces). In between the consumption of parts decreases. Table 1 in appendix 14 depicts the groups, the number of spare part types per group, the total consumption of parts per group and the average price of the parts per group.
To calculate the Level Of Service, formula 1 of section 6.3 will be used. In section 6.3. it has been mentioned that the ptc for a group of spare parts can be calculated very well. However, in the same section it has also been mentioned that the calculation of the FR_G is not a cast-iron calculation and therefore should not be executed for fast moving spare parts. With respect to the fast movers (group 1 and 2), it is recommended to calculate the FR_p for each individual part. This increases the amount of work, but as the number of real fast movers is not large (173 partnumbers with an average monthly demand per SSP of one or more pieces) the workload will be acceptable. There are 80 SSPs throughout Europe.
Therefore, with respect to the fast movers, formula 1 will be used in it's original shape.

Regarding the other groups (3-11) formula 1 has been adapted by replacing ptc_p by ptc_G and FR_p by FR_G.
Thus the formula can be written as:

$$LOS = \sum_{G=3}^{11} ptc_G * FR_G \qquad (6)$$

where LOS = overall Level Of Service, $0 \leq LOS \leq 100$
G = groupnumber
ptc = percentage of total consumption, $0 \leq ptc \leq 100$
FR = fill-rate, $0 \leq FR \leq 1$

In order to calculate the fill-rate it is assumed that the demand for the spare parts is a Poisson process. Due to lack of historic information this could not be checked properly. However, the Poisson distribution is often used to approximate the demand for spare parts (Vereecke and Verstraeten (1994) and Hill (1992)).

Calculation of stocking individual parts in every SSP.
The calculation of the LOS for each individual fast mover will be illustrated by means of the fastest moving spare part of the assortment of 30,000 parts. The figures can be found in appendix 14. The European consumption of this spare part amounts 5410 pieces in six months. This approximately equals an average of 12 pieces per month per SSP. The ptc_p of this part amounts 1.03 % ((5410/524,668) x 100). The replenishment time, from Nijmegen to the SSPs, for each failed unit is assumed to be distributed with mean time 3 days (1/10 month). According to formula 4 the Poisson distribution for the number of units due in (DI) is given by:

$$\Pr(DI = i) = \frac{(1.2)^i e^{-1.2}}{i!} \qquad (7)$$

Based on a particular stock level (s), this formula enables the calculation of the expected fill-rate. Table 7 depicts the fill-rate and the contribution to the overall Level Of Service for different stock levels.

Stock level (s)	Fill-rate = Pr{DI ≤ s-1}	FR(s)	(contributed) LOS
0		0	0
1	Pr{DI=0}	0.301	0.31
2	Pr{DI=0} + Pr{DI=1}	0.662	0.68
3	Pr{DI=0} + ... + Pr{DI=2}	0.879	0.91
4	Pr{DI=0} + ... + Pr{DI=3}	0.966	0.99
5	Pr{DI=0} + ... + Pr{DI=4}	0.992	1.02
6	Pr{DI=0} + ... + Pr{DI=5}	0.998	1.03
7	Pr{DI=0} + ... + Pr{DI=6}	0.999	1.03

Table 7 Calculation of fill-rate and LOS for a single spare part

Table 7 shows that in order to acquire an expected fill-rate equal to or bigger than 0.99, a stock level of five units per SSP is required. As the price of this part amounts $ 35, the total investment in stock for this part will be $ 14,000 (5 x 80 x $ 35). In case the stock level is determined to be equal to five units, this part is expected to contribute approximately 1.02% (0.992 x ptc_p) to the overall Level Of Service.
The preceding calculation has to be executed for all 173 fast moving spare parts.

Calculation of stocking groups of parts in every SSP.
The calculation of the fill-rate for a group will be illustrated by means of group 3 (appendix 14).
This group contains 52 partnumbers with a demand between 400 and 500 units during the six month period. The total consumption of the parts in this group amounts 23,497 and the average price per part is $ 240. Hence, the average demand per month per SSP is 0.94 pieces (23,497/(52 x 6 x 80)). Once again it is assumed that the demand is a Poisson process and the replenishment time, from Nijmegen to the SSPs, for each failed unit is distributed with mean time 3 days (1/10 month).

Consequently, the steady-state probability distribution for the number of units due in has a Poisson distribution with mean 0.094.
Table 8 shows the fill-rate with respect to stock levels up to 3 units.

Stock level (s)	FR(s)
0	0
1	0.910
2	0.996
3	0.999(8)

Table 8 Calculation of fill-rate for a group of spare parts (group 3)

In case Digital decides that an average fill-rate of 0.910 is adequate for this group of spare parts each SSP should keep one unit of every spare part on stock. Roughly, this will require an investment of $ 998,400 (1 x 52 x 80 x $240).
As the ptc_G of this group equals 4.5% ((23,497/524,668) x 100) the contribution to the overall Level Of Service will be around 4.1%.

Calculation of stocking groups of parts in a *central* SSP per country.
Up to here the focus has been on determining the stock level for spare parts in every SSP. Nonetheless, many times the AMC (Average Monthly Consumption) per SSP per spare part is far less than 1. In that case, stocking spare parts in central warehouses in the countries is preferred, rather than stocking the parts in every SSP. The number of countries equals 16 (see appendix 4).
For example, the AMC per country per spare part in group 7 is 0.72. With an average replenishment time, from Nijmegen to a *central* SSP, of 3 days (1/10 month), the steady-state probability distribution for the number of units due in has a Poisson distribution with mean 0.072.
Table 9 shows the fill-rate with respect to stock levels up to 2 units.

Stock level (s)	FR(s)
0	0
1	0.931
2	0.998

Table 9 Calculation of fill-rate for a group of spare parts (group 7)

A (central) stock level of 1 unit in every country for every part in this group will result in an expected fill-rate of 0.931. Consequently, about $ 3,900,000 (1 x 777 x 16 x $310) will have to be invested. As the ptc_7 is 10.3%, the contribution to the overall Level Of Service will be 9.59%.
Of course the feasibility of central stocking depends on the time that is allowed for spares to arrive at the customer.

Calculation of stocking groups of parts centrally in Europe (Nijmegen).
For al lot of spares even central stocking in the countries is not acceptable, because of the very low demand. With respect to these parts, central European stock should be considered. Parts of group 9 (ptc_9 = 5.2%), for example, have an European AMC of 0.84 (27,199/ (5407 x 6)). It is important to notice that in this case the average replenishment time from the vendors to Nijmegen has to be determined. It is assumed that this time is equal to 0.5 months. Consequently, the steady-state probability distribution for the number of units due in has a Poisson distribution with mean 0.42.

Table 10 shows the fill-rate at Nijmegen with respect to stock levels up to 3 units.

Stock level (s)	FR(s)
0	0
1	0.657
2	0.933
3	0.991

Table 10 Calculation of fill-rate for a group of spare parts (group 9)

A stock level of two units calls for an investment of around $ 4,400,000 (1 x 5407 x $407) and results in an expected fill-rate of 0.933 (contribution to overall Level Of Service = 4.9%). In the same way, these figures can be calculated for the other stock levels.
In case of a central European stock the impact of the service response time is even bigger than in the event that parts are stocked centrally in the countries. Despite the very low demand, it therefore is expected that some parts simply have to be stocked in the countries, or even in the local warehouses. However, no clearly defined information about the response time is available now.

Calculation of *replenishment* stock in Nijmegen.
In case spare parts are stocked in every SSP or in one central SSP per country, the replenishment is supposed to be taken care of by Nijmegen. In order to execute this task properly, Nijmegen has to maintain a replenishment stock, which has to be based on the European AMC, an average replenishment time from the vendors to Nijmegen and a desired fill-rate.
One of the most important properties of Poisson distributed variables is, that the sum of k Poisson distributed variables with mean $\lambda_1, \lambda_2, \ldots, \lambda_k$ is again a Poisson distributed variable with mean $(\lambda_1 + \lambda_2 + \ldots + \lambda_k)$ (Buijs (1990)). Consequently, as it has been assumed before that the AMCs per SSP and per country are Poisson processes, the European AMC is also a Poisson process, with mean equal to the sum of the individual means.
However, this will often result in a Poisson distributed variable with a very large mean. Calculating fill-rates will be a very time consuming activity then. Therefore, another rule defined by Buijs (1990) will be used. This rules defines that if $\lambda \geq 10$, the Poisson distribution can be replaced by the Normal distribution, with $\mu = \lambda$ and $\sigma = \sqrt{(\lambda)}$.

The use of the Normal distribution will be illustrated by means of the fastest moving spare part, which has been mentioned before. The European demand for this part is a Poisson process with monthly mean 901.67 pieces. Based on an average replenishment time from the vendors to Nijmegen of 0.5 months, the steady-state probability distribution for the number of units due in (DI) has a Poisson distribution with mean 450.8, or

$$\Pr(DI = i) = \frac{(450.8)^i e^{-450.8}}{i!} \qquad (8)$$

Since the mean is bigger than 10, the Normal distribution can be used here.
Thus, the Normal distribution for the number of units due in (DI) is given by:

$$DI \sim N\left(\mu = 450.8, \sigma = \sqrt{450.8}\right) \qquad (9)$$

In order to calculate the minimum replenishment stock level (s), the desired fill-rate at Nijmegen has to be determined in advance. In case the desired fill-rate is determined to be at least 0.99, the condition for the probability of the number DI is given by:

$$\Pr(DI > (s-1) + 0.5) \leq 0.01 \qquad (10)$$

The value 0.5 is called the *continuity correction factor* for the normal approximation to the Poisson probability (Mendenhall *et al.* (1989)).
The table of the standard Normal distribution in appendix 16 learns that z has to be 2.33, where z is the standard normal variable, defined as:

$$z = \frac{DI - \mu}{\sigma} \qquad (11)$$

Thus, the replenishment stock level (s) can be calculated by solving the following equation:

$$2.33 = \frac{((s-1) + 0.5) - 450.8}{\sqrt{450.8}} \qquad (12)$$

The solution for s must always be rounded off to the first higher integer; here the replenishment stock level (s) is determined to be 501 pieces.

The preceding calculation can be executed for all spare parts or groups of spare parts, which are stocked in every SSP or in a central SSP per country. Of course it is not necessary to keep up a replenishment stock for groups of parts, which are already stocked centrally in Nijmegen.

To facilitate all calculations mentioned in this section, a **spreadsheet** has been developed. The spreadsheet and its description are dealt with in appendix 15. It is highly recommended to read this appendix, before reading section 6.5 and section 6.6.
As can be concluded from the spreadsheet and from the calculations in the last two sections, only the investments in stock (and consequently the interest costs) necessary to acquire a pre-specified LOS, are taken into account. Transport-, warehousing- and handling costs, which are also physical distribution costs (Van Goor *et al.* (1994)) are not taken into account. Although these costs should not be neglected totally, it can be shown by means of the physical distribution strategy framework (figure 14) developed by Van Goor *et al.* (1994), that the interest costs are the most important physical distribution costs for Digital.
Based on the product characteristics *value density* (value per m^3 in US$/$m^3$) and *packaging density* (number of packaging units per m^3) Van Goor *et al.* (1994) have developed the framework to determine the accents of the physical distribution strategy with respect to the total physical distribution **costs**. The framework is based on two statements:

1. an increasing value density goes along with an increasing relative share of interest (inventory) costs and a decreasing relative share of transport- and warehouse costs. The reverse statement is true for products with a low value density;
2. an increasing packaging density goes along with an increasing relative share of handling costs. The reverse statement is true for products with a low packaging density.

Figure 14 depicts the framework.

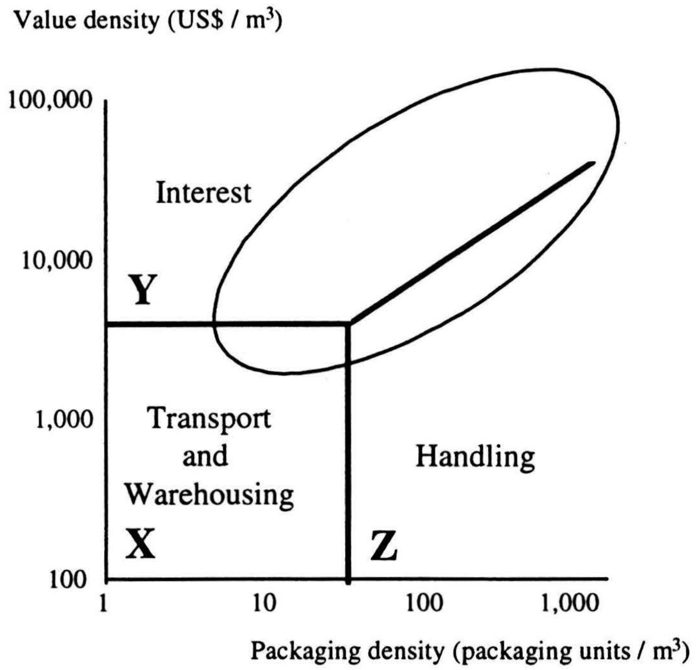

Figure 14 The strategy framework by Van Goor *et al.* (1994)

The framework consists of three segments. Each segment represents the costs that have the highest share in the total physical distribution costs. Therefore, each segment requires a different accent in the physical distribution strategy.
The physical distribution strategy for segment X must be focused on minimizing the transport- and warehousing costs. With respect to products in segment Y the strategy must be focused on minimizing the inventory (interest) costs by decreasing pipeline inventories (faster transport) and centralizing of stock. However, centralization should only be considered if the products can be 'sold' in a large number of countries. The strategy for products in segment Z must be focused on minimizing the handling costs. In this segment mechanization of the handling process can save expenses.
The position of Digital spare parts is depicted by a rough range (source: Prins (1996)). The range shows that the spare parts cover all segments of the framework, but are mainly positioned in the segment Y. Therefore, from a theoretical point of view, it is clear that the focus can be on interest costs.

With the assistance of the spreadsheet three scenarios have been calculated. Before the scenario's were calculated, a sensitivity analysis had been carried out, in order to determine the most important (or sensitive) parameters that are used in the spreadsheet.
The sensitivity analysis is dealt with in section 6.5. The three scenarios are described in section 6.6.

6.5 Sensitivity analyses of parameters

As mentioned in appendix 15, the spreadsheet consists of two worksheets; one worksheet to calculate *stock levels*, the (contribution to the) *Level Of Service* and the *average lead time to the 'customers'* for fast movers and one worksheet to calculate these figures for slow movers. Next to that, the second worksheet also determines the location of where the (groups of) slow movers have to be stocked. (Customers is written between apostrophes, as a customer could also be an engineer.)
The parameters, used in the two worksheets, can be summarized as follows:

1. Average replenishment time in **months** from Nijmegen to the SSPs*;
2. Average replenishment time in **months** from vendors to Nijmegen*;
3. Minimum required fill-rate at the SSPs*;
4. Minimum required fill-rate at Nijmegen*;
5. Number of SSPs;
6. Number of countries;
7. Minimum AMC (Average Monthly Consumption) per country per spare part, for stocking parts in every SSP*;
8. Minimum AMC per country per spare part, for stocking parts centrally in countries*;
9. Average lead time in **days** from the SSPs to the 'customers';
10. Average lead time in **days** from (central) country stocking point to 'customers';
11. Average lead time in **days** from Nijmegen to the 'customers';

The first six parameters were already used in the calculations, described in section 6.4. Parameter 6 and 7 are used to determine the stocking location for groups of slow movers. The last three parameters are used to determine the average lead time to the 'customers'. The lead time depends on the stocking location. The more centrally parts are stocked, the longer the lead time to the customers will be.

A sensitivity analysis of six parameters (indicated by a *) has been carried out. During these analyses the influence of the parameters on the *investment in stock* and the *Level Of Service* (and for some parameters the influence on the *lead time to the 'customers'*) has been determined. An extensive description of the sensitivity analyses has been included in appendix 17.

The sensitivity analyses of the six parameters learned that three parameters have a large influence on the Level Of Service. These parameters are:

- the average replenishment time in months from Nijmegen to the SSPs;
- the minimum required fill-rate at Nijmegen;
- the minimum required fill-rate at the SSPs.

As Digital wants to determine how much stock has to be maintained in order to fulfill a pre-specified Level Of Service, it is recommended to use these parameters as *control parameters* in the worksheets.
After Digital has determined the required Level Of Service (management decision), first the most likely minimum value of the parameter 'replenishment time from Nijmegen to the SSPs' should be inserted into the worksheets. It should be the most likely minimum value, for this means that the amount of stock needed is limited (see appendix 17).

After that, the value of the required minimum fill-rate at Nijmegen should be inserted. It is recommended to strive for a considerable high fill-rate at Nijmegen, because the required increase of the investments in stock is less than the required increase of investments in stock for high fill-rates at the SSPs (see appendix 17). Though, figure 7 in appendix 17 learns that fill-rates at Nijmegen, higher than 0.99, require a disproportionate extra investment in stock.
Finally, the value of the minimum required fill-rate at the SSPs must be inserted. Then, the total Level Of Service will show, whether or not the fill-rates at the SSPs are high enough.
If the total (calculated) LOS is high enough, the spreadsheet shows the recommended stock levels and the amount of money that is involved.

Next, Digital has to check whether or not the average lead times to the 'customers' are acceptable. If not, the values of the parameters 'minimum AMC per ... in every SSP' and 'minimum AMC per ... in countries' must be adapted. Decreasing the values of these parameters results in shorter average lead times. Increasing the values of these parameters results in longer average lead times. As these parameters have a small effect on the Level Of Service (see appendix 17), the calculated Level Of Service should be compared again to the required Level Of Service.

As the worksheet for slow movers (called 'Groups') offers the possibility to distinct between fill-rates of different groups, some 'fine-tuning' could be done in order to decrease the total investment in stock. However, the total Level Of Service should be checked again.

The parameter 'replenishment time from the vendors to Nijmegen' should just be as low as possible (but also realistic), in order to limit the investments in stock (see appendix 17)!

At the moment, the values of the parameters for which no sensitivity analysis has been carried out (parameter 5, 6, 9, 10 and 11), are supposed to be constant. However, if necessary these values can be changed in the worksheets (see appendix 15).

The spreadsheet has been applied to determine the locations and the amount of stock that is needed, in case of three different scenarios. This has been done according to the recommended use of the worksheets, and based on a required overall Level Of Service and a maximum allowed lead time to the 'customers'. The scenarios are dealt with in section 6.6.

6.6 Scenarios

Based on the required overall Level Of Service and the different stocking locations three scenarios have been investigated. The name of the scenarios depends on the percentage of demand that is supposed to be met instantaneously by the SSPs, by central country stocking rooms or by Nijmegen.

Scenario 80-0-20
This scenario is based on the following requirements:
- the overall Level Of Service has to be at least 95%;
- approximately 80% of the total 'customer' demand has to be met instantaneously by the SSPs and 20% of the 'customer' demand has to be met instantaneously by Nijmegen.

The second requirement is another way of looking at the parameters 7 and 8, mentioned in the previous section. First of all, parameter 7 and 8 have to have the same value, as stocking centrally in the countries is not considered here. The value of parameter 7 and 8 is determined is such a way, that the sum of the total ptc of the fast movers (37.6%) and the ptc of the groups, that are qualified for stocking in every SSP, is around 80%. Hence, the value of parameter 7 and 8 has to be lower than 0.721 and higher than 0.225 (see part B of appendix 15, worksheet 'Groups', column E). In the worksheet 'Groups' parameter 7 and 8 are set equal to 0.5.
According to the directions of use, described in the previous section, the values of the other parameters were determined, under the restriction that the overall Level Of Service has to be at least 95%.
The results of the calculations are summarized in table 11. The entire spreadsheet is depicted in appendix 15B. The appendix shows the results in detail. It should be noticed that the results, depicted in table 11, do not pretend to be the mathematically optimal solution. They offer an acceptable solution, under the given restrictions.

Description	**Investment (k$)**	**Lead time (days)**	**Level Of Service (%)**
Investm. in fast movers	9,148.2		
Investm. in slow movers	64,842.0		
Total investment	73,990.2		
Av. lead time fast movers to 'customers'		0.54	
Av. lead time slow movers to 'customers'		1.22	
Overall Level Of Service			95.38

Table 11 Results of scenario 80-0-20

From appendix 15 B, two other figures can be calculated in which Digital is interested.
The first one is the Level Of Service to the 'customer' for parts, delivered by the SSPs: 96.7%.
The second figure is the Level Of Service to the 'customer' for parts delivered by Nijmegen: 90.2%.
It is obvious, that the overall Level Of Service, depicted in the table, is a weighted average of these two figures.

Finally, it is interesting to compare the total investment in stock, depicted in table 11, with the investment in stock at the end of February 1997, which amounted approximately 107.3 million dollar. Thus, the spreadsheet recommends an investment in stock that is around 33 million dollar <u>less</u> than the investment in February 1997.

<u>Scenario 50-0-50</u>
This scenario is based on the following requirements:
- the overall Level Of Service has to be at least 95%;
- approximately 50% of the total 'customer' demand has to be met instantaneously by the SSPs and 50% of the 'customer' demand has to be met (instantaneously) by Nijmegen.

Again, the second requirement determines the values of parameter 7 and 8, which are described in the previous section. This time, both values have to have (the same) value that is lower than 2.508 and higher than 1.454 (see appendix 18, worksheet 'Groups', column E). For both parameters the value '2' has been inserted.

In the same way as described for the previous scenario, the values of the other parameters (under the restriction of the minimum Level Of Service), have been determined. The results of the calculations are summarized in table 12. The entire spreadsheet is depicted in appendix 18. Again , the results depicted in table 12 do not pretend to be a mathematically optimal solution. They pretend to be an acceptable solution, under the given restrictions.

Description	**Investment (k$)**	**Lead time (days)**	**Level Of Service (%)**
Investm. in fast movers	9,148.2		
Investm. in slow movers	40,129.1		
Total investment	49,277.3		
Av. lead time fast movers to 'customers'		0.54	
Av. lead time slow movers to 'customers'		1.90	
Overall Level Of Service			95.06

Table 12 Results of scenario 50-0-50

The detailed results of appendix 18 enable the calculation of the specified Levels of Service of the SSPs and Nijmegen.
The Level Of Service amounts 98.5% for parts, delivered by the SSPs, and 90.5% for parts, delivered by Nijmegen. The overall Level Of Service, mentioned in table 12, is a weighted average of these two Levels Of Service.
It is clear that in this scenario the total investment in stock is much lower than in the previous scenario. The calculated investment in stock is approximately 58 million dollar less than the investment in stock at the end of February 1997. This is quite obvious, because central stocking is 'cheaper' than stocking in local warehouses. However, central stocking does also increase the average lead time to the customer. It will depend on the contracts with the customers, whether or not the increase of the lead time is acceptable.

Throughout this report the (contracted) response times to the customers has been mentioned very often. It has been explained that this factor is very important for the service organization. Based on this importance, the response times should be included in the stocking strategy. However, it has also been described, that there are several circumstances which limit the use of the response times. Nevertheless, the spreadsheet enables the simulation of a situation in which the contracted response times, with respect to <u>all</u> spare parts, do not allow spare parts to be stocked only in Nijmegen. In other words, the response times require all spare parts to be stocked in the SSPs. Of course this situation will never occur, but it is interesting to see the consequences for the investment in stock. Such a situation can be described as 'scenario 100-0-0', which means that all 'customer' demand has to be met instantaneously by the SSPs.

<u>Scenario 100-0-0</u>
The overall Level Of Service has to be 95% again.
In this case the value of parameter 7 and 8 has to be '0'.
Table 13 depicts the summarized results of the calculations and the entire spreadsheet is included in appendix 19.

For this scenario it is not necessary to distinct between a Level Of Service for parts delivered by the SSPs and a Level Of Service for parts delivered by Nijmegen, because all demand for parts is supposed to be met instantaneously by the SSPs.
It is clear that this scenario requires a huge investment in stock. Although this scenario will not occur, it is important to notice that the contracted response times can have a large impact on the required investments in stock.

Description	Investment (k$)	Lead time (days)	Level Of Service (%)
Investm. in fast movers	7,226.8		
Investm. in slow movers	420,732.3		
Total investment	427,959.1		
Av. lead time fast movers to 'customers'		0.66	
Av. lead time slow movers to 'customers'		0.56	
Overall Level Of Service			95.14

Table 13 Results of scenario 100-0-0

Therefore, contracting short response times should be limited, or, in case the customers request short response times, contract revenues must be in accordance with the increase of investment in stock.

Conclusion
It is clear that the major part of the 'recommended' stocking strategy depends on decisions that have to be made (in advance) by Digital. Digital has to decide about the required Level Of Service, if necessary, specified per stocking location (see scenarios). Moreover, Digital has to decide what part of the assortment is to be delivered from the SSPs, central country stocking rooms or Nijmegen. This decision effects the average lead time to the customers, which is an important aspect of a service organization and which is determined by the service contracts. It has been shown that contracted response times have a large impact on the investments in stock. Short response times means that parts have to be stocked in local stocking rooms.

As mentioned before, the results of the spreadsheet do not reflect a mathematically optimal situation. Yet, the spreadsheet is a tool to determine a stocking strategy, which is acceptable under specific restrictions. As the spreadsheet consists of many different parameters, the user is able to simulate quite a number of different scenarios.
The first results show that there are extensive possibilities to decrease the investments in stock. The ultimate savings depend on the scenario that is going to be implemented by Digital.
Due to time restrictions, it was not possible to determine the ultimate strategy together with people of Digital. Nevertheless, the theory in section 6.3 and 6.4, the extensive description of the spreadsheet (appendix 15), and the sensitivity analysis (appendix 17) offer enough instructions for Digital to use the spreadsheet and determine the ultimate stocking strategy.

In order to facilitate the use of the spreadsheet an extra front-end worksheet has been developed that allows the user to insert the parameters and interpret the bottom line results on one screen. A print of this worksheet is included in appendix 20.

7 Conclusions and Recommendations

The research question of the graduation project was focused on an integrated European stocking strategy for spare parts. During the project an answer had to be found to the following two questions:
1. Which spare parts have to be stocked?;
2. How much stock has to be maintained of those parts and where do they have to be stocked?

Literature research learned that conventional inventory control methods, which are based on statistical models striving for optimization, are not applicable to the major part of the assortment of spare parts. The suitability of such models decreases with the decrease of the frequency of demand. Even more important is the fact that, before coming to any conclusion about the stocking strategy for spare parts, it is necessary to decide on the importance of the parts for the service process. This importance is also known as *criticality*. Based on criticality, spare parts can be assigned to different categories and appropriate levels of control with respect to the stocking strategy can de established over each category.

Therefore, the first part of the project focused on the development of a tool which can be used to classify the parts according to their importance to the service process.
A good method to group parts according to their criticality is the VED analysis, which aims at classifying spare parts as *Vital*, *Essential* or *Desirable* for the service process. Several important factors in the spare parts environment, in which Digital operates, were determined and those factors were investigated with respect to their suitability for classifying parts as vital, essential or desirable.
The tool or framework resulting from this part of the assignment can be used to solve the first question: "Which spare parts have to be stocked?".
In the second part of the project a spreadsheet has been developed to support the design of an integrated European stocking strategy. Again, a framework underlies the development of the spreadsheet. By applying the spreadsheet, answers can be found to the second issue: "How much stock has to be maintained of those parts and where do they have to be stocked?".

A number of conclusions and recommendations have been presented, which are summarized in this chapter.

7.1 Conclusions

1. *For customer service the consumption in pieces is more important than the consumption in dollars.*

Therefore the decision whether or not to stock parts must not be based on turnover (classic Pareto analysis), but must be based on consumption (in pieces).

2. *Important factors with respect to the criticality of spare parts are:*
    - *service response time*
    - *functionality*

The service response time is defined as the time that is allowed for spares to arrive at a customer after a customer has called. The service response time is determined by the service contracts with customers.
According to the factor functionality a spare part is either 'functional' or 'cosmetic'. Functional means that when a part breaks down, also the system to which it belongs breaks down. A failure of a cosmetic part does not influence the operation of the system to which it belongs.

3. *At the moment the factor 'service response time' is not suitable for classifying parts as vital, essential or desirable.*

This is due to the fact that a spare part can occur in different products for which different response times can be contracted by different customers.

4. *The decision not to stock cosmetic parts can considerably decrease the investments in stock.*

Concerning January 1997, not stocking cosmetic Compaq parts, would result in a decrease of approximately $ 128,000 (2.6% of total) invested in stock. Noticing the fact that the business for Compaq only concerned 1886 partnumbers at that moment, the possible savings (decreases of investments) can be much higher for the entire Digital assortment.

5. *When answering the question "how much and where to stock parts?", the most important factors are:*
    - *usage (in pieces);*
    - *price;*
    - *service response time.*

Although being an important factor, the 'service response time' cannot be used for answering this question, due to the fact mentioned under conclusion 3. Next to some other parameters, the first two factors have been used in a direct way to develop a spreadsheet, which supports the design of an European integrated stocking strategy. However, by applying the spreadsheet it is possible to show the impact of the service response time on the investments in stock.

6. *In general the stocking strategy can initially be focused on the interest costs or, in other words, on the investment in stock.*

This has been determined, by means of two product characteristics of computer spare parts. The two product characteristics are 'the value density' and 'the packaging density'.

7. *The service response time has a huge impact on the required investments in stock.*

In an indirect way the impact of the service response time on the investments in stock can be shown by means of the spreadsheet. The shorter the response time, the more locally parts have to be stocked.

8. *The first results of the calculations with the spreadsheet show that there are extensive possibilities to decrease the investments in stock.*

Due to time restrictions, it was not possible to determine the ultimate stocking strategy. However, the calculation of some scenarios led to the conclusion that a decrease of more than 20 million dollar, invested in stock throughout Europe, is possible. The calculations of the spreadsheet were compared with the investment in stock in February 1997, concerning 30,000 partnumbers.

7.2 Recommendations

1. *Digital should define standard response times for spare parts, in order to be able to use the factor 'service response time' as a parameter to determine the stocking strategy.*

This can solve the problem of not being able to assign spare parts to individual classes with respect to the service response time. As well for the first issue, "Which parts have to be stocked?", as partly for the second issue, "Where do the parts have to be stocked?", standard response times for spare parts can be very useful. (This also enables the use of the Analytic Hierarchy Process (AHP) in combination with the VED analysis, in case Digital is willing to use AHP.)

2. *Digital must differentiate its spare parts as being functional or cosmetic, in order to be able to use the framework for dealing with the issue "Which spare parts have to be stocked?".*

During the assignment the framework could only be used with respect to Compaq spare parts.

3. *In case it is decided not to stock cosmetic spare parts, the service contracts with customers should mention that the agreed service response time only holds for functional spare parts.*

4. *In case the customers request short response times, contract revenues must be in accordance with the increase of investment in stock.*

By means of the spreadsheet it has been shown that short response times have a huge impact on the required investments in stock.

5. *In order to design a proper European integrated stocking strategy, the following activities should be executed consecutively:*
    - *determine which parts have to be stocked by means of the framework that is based on the factors 'consumption in pieces' and 'functionality';*
    - *determine an acceptable integrated stocking strategy for the selected spare parts by means of the spreadsheet (an extensive description of the spreadsheet and a direction of use are included in the appendices).*

This recommendation refers to the present situation, in which it is not possible to use the factor 'response time' directly for determining an integrated European stocking strategy.

6. *Further research is necessary with respect to the way standard response times for spare parts can be introduced.*

7. *Further research is necessary with respect to the relation between response time, investments in stock and contract revenues.*

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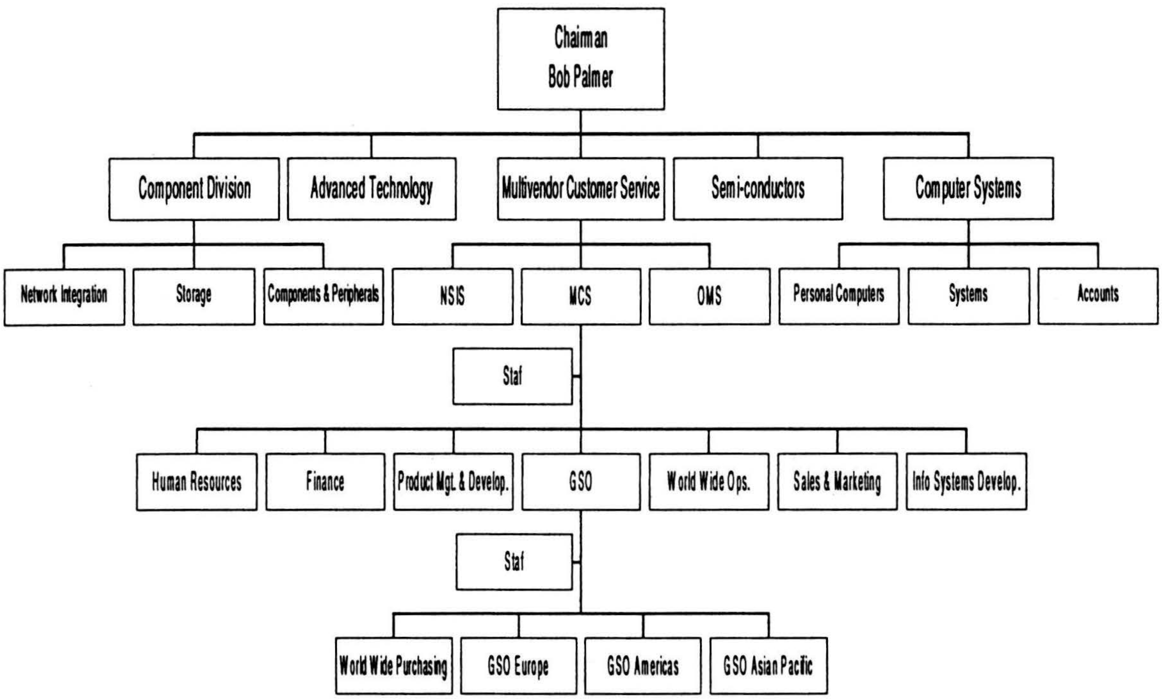
List of abbreviations

AHP	Analytic Hierarchy Process
AMC	Average Monthly Consumption
AWSP	Authorized Warranty Service Provider
BO	Back Order
DEC	Digital Equipment Corporation
DI	Due In
ESSC	European Services and Supply Center
FR	Fill-Rate
FRU	Field Replaceable Unit
GSO	Global Supply Operations
ILO	International Logistic Organization
LOS	Level Of Service
MCS	Multivendor Customer Services
NBD	Next Business Day
2BD	Two Business Days
5BD	Five Business Days
OH	On Hand
ptc	percentage of total consumption
RSL	Recommended Spares List
SIC	Statistical Inventory Control
SSP	Service Stocking Point
TSL	Target Stock Level
VED	Vital, Essential and Desirable
WOH	Weeks On Hand

Appendices

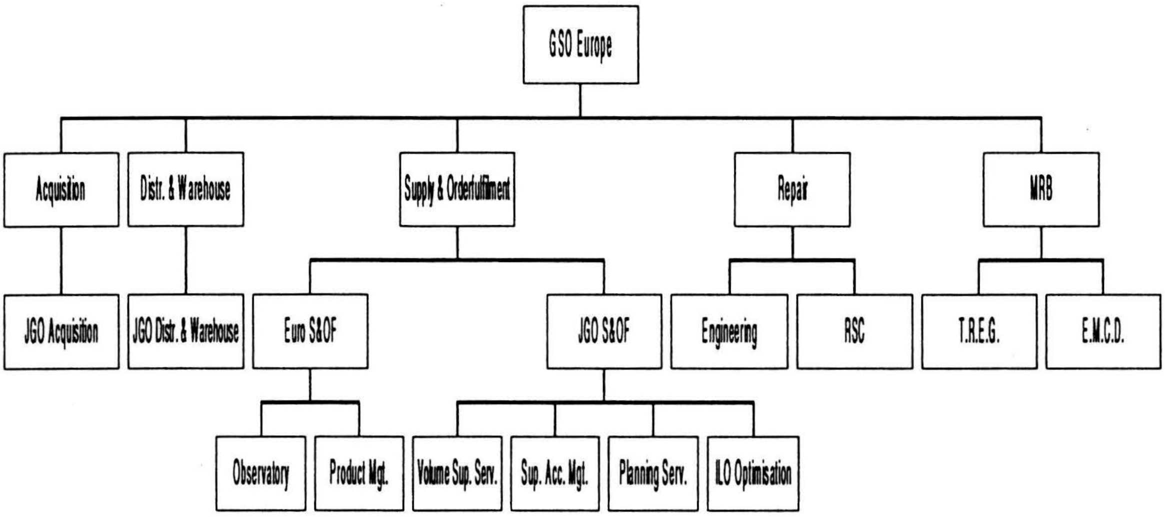
Appendix 1

Organizational chart Digital Equipment Corporation



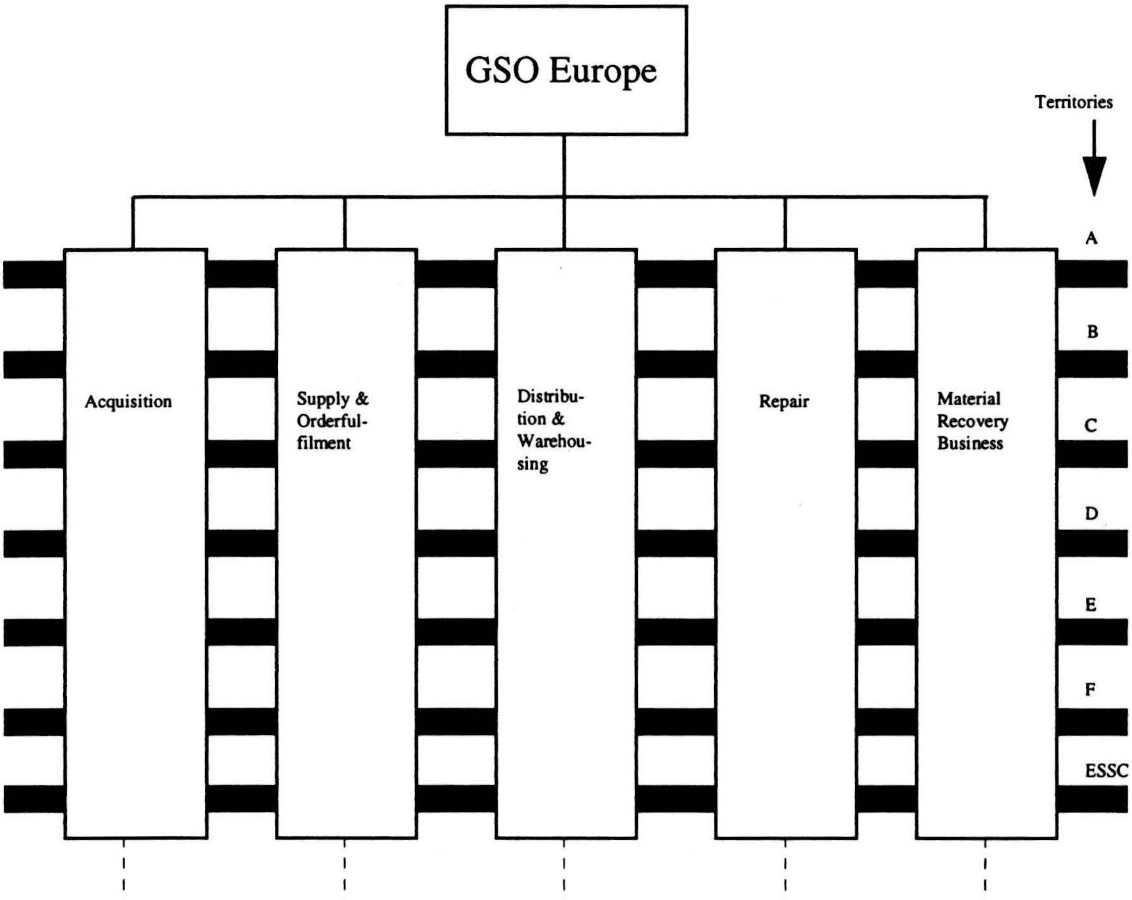
Appendix 2

Organizational chart GSO Europe



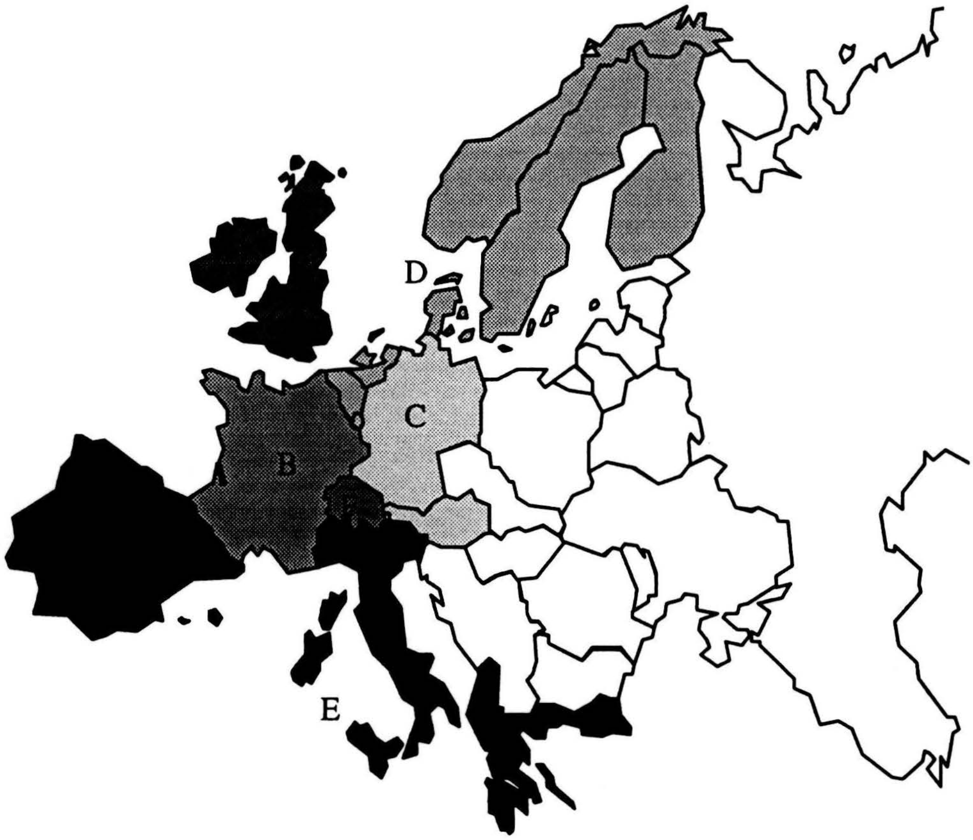
Appendix 3

Organization of the ESSC within the GSO Europe framework



Appendix 4

Territories GSO Europe



Territory A: United Kingdom and Ireland
Territory B: France
Territory C: Germany and Austria
Territory D: Benelux, Denmark, Norway and Finland
Territory E: Portugal, Spain, Italy, Greece, Turkey and Israel
Territory F: Switzerland

Appendix 5

Example of the Analytic Hierarchy Process

For this example the hierarchy structure mentioned in chapter 4 is used. The criteria and alternatives are generally defined as criterion 1 to 3 and alternative 1 to 3. Once the hierarchical model has been structured for a given decision problem, pairwise comparisons of criteria with respect to the overall objective are made. This results in a comparison matrix. The pairwise comparisons are made using the nine-point comparison scale suggested by Saaty (1980) (see appendix 6). The resulting comparison matrix is depicted in table 1.

Comparison of criteria w.r.t. goal	Criterion 1	2	3	Normalized Eigenvector
Criterion 1	1	2	2	0.50
Criterion 2	½	1	1	0.25
Criterion 3	½	1	1	0.25

Table 1 AHP Judgments Matrix for Level 2

Similarly, the decision alternatives are also compared pairwise with respect to each criterion and the corresponding pairwise comparison matrices are obtained (see table 2).

Comparisons of alternatives	Alternative 1	2	3	Normalized Eigenvector
Criterion 1				
Alt. 1	1	½	¼	0.136
Alt. 2	2	1	1/3	0.229
Alt. 3	4	3	1	0.625
Criterion 2				
Alt. 1	1	½	¼	0.143
Alt. 2	2	1	½	0.286
Alt. 3	4	2	1	0.571
Criterion 3				
Alt. 1	1	½	1/3	0.163
Alt. 2	2	1	½	0.297
Alt. 3	3	2	1	0.540

Table 2 AHP Judgment Matrix for Level 3

Focusing on table 2, the comparison of alternative 3 and 1 with respect to criterion 3 results in a figure 3. According to the comparison scale of Saaty (1980) this means that alternative 3 is 'weakly more important' than alternative 1 with respect to criterion 3.

The next step consists of the computation of a vector of priorities from the given matrices.
In mathematical terms the 'principal eigenvector' is computed (Kolman (1993)), and when normalized becomes the vector of priorities. The computation of the eigenvector will not be explained here. The meaning of an eigenvector is that it provides a measure of each criterion's relative importance to the decision maker in the light of the overall objective and, in this case, also a measure of each alternative's relative importance to the decision maker in the light of a particular criterion.

The computed normalized eigenvectors are depicted in the last column of table 1 and 2.

The composite priorities or weights for each criterion-alternative combination are calculated in table 3.
These weights are computed by multiplying each alternative's relative importance by the 'level 2 priority' of the corresponding criterion.

Criteria	Level 2 priorities	Alternatives 1	2	3	Composite weights 1	2	3
Crit. 1	0.50	0.136	0.229	0.625	0.0680	0.1145	0.3125
Crit. 2	0.25	0.143	0.286	0.571	0.0357	0.0715	0.1427
Crit. 3	0.25	0.163	0.297	0.540	0.0407	0.0742	0.1350

Table 3 Composite weights for criterion-alternative combinations

The weights depicted in the shaded columns can be used for the absolute measurement of the criticality of a spare part.
Suppose a certain spare part has the following characteristics:

Criterion 1: Alternative 2
Criterion 2: Alternative 3
Criterion 3: Alternative 3

The total numerical value of the composite weights added together for this spare part are 0.11450+0.14275+0.13500 = 0.39225. This also serves as the absolute *measurement of the criticality* of the spare part considered in this illustration.
This value is compared with the **numerical limits, specified by management**, for classifying spare parts as Vital, Essential, or Desirable. These numerical limits have been specified by the management after due consideration of the impact due to non-availability of different spare parts.

For example spare parts for which all the criteria have alternative number "1" could be classified as Desirable. When all the criteria characterizing a spare part have number "2" as alternative that spare could be classified as Essential. Similarly, when all the criteria for a spare part have number "3" as alternative it then is classified as Vital.
The management could determine the upper limit for the Desirable class as:

Criterion 1 and alternative 1 (0.06800)
Criterion 2 and alternative 1 (0.03575)
Criterion 3 and alternative 2 (0.07425)

Then the total of the above three composite weights, 0.1780, is the upper limit of the Desirable class.

In the same way management could determine the lower boundary condition for the Vital class as:

Criterion 1 and alternative 3 (0.31250)
Criterion 2 and alternative 1 (0.03575)
Criterion 3 and alternative 1 (0.04075)

Then the total of the above three composite weights, 0.3890, is the lower limit of the Vital class.

The boundary conditions for the VED classification in this example can therefore be specified as follows:

Total of composite weights	Class
> 0.389	Vital
> 0.179 and < 0.388	Essential
< 0.178	Desirable

Table 4 Boundary conditions for classes

Hence, the spare part considered in the illustration should be classified as Vital since it has a total composite weight of 0.39225, which is greater than the lower limit of 0.3890.

Similar calculations can be made for all the other spare parts, after evaluating which alternative is applicable to them corresponding to each criterion. This last step, assigning the parts to the classes, can be automated very well, because spare parts and data about the relevant criteria and alternatives can be put in a database. The hierarchical model and the relative weights can be a permanent framework in the data base.

Appendix 6

Comparison scale suggested by Saaty (1980)

The pairwise comparisons are made using the nine-point comparison scale suggested by Saaty (1980).
Assume the relative importance of the criteria A, B, C and D with respect to a certain overall objective have to be determined.
First of all the criteria are put in a matrix:

Overall objective	A	B	C	D
A		position (A,B)		
B				
C	position (C,A)			
D				

Table 1 Comparison matrix

The comparison of importance is always of a criterion appearing in the column on the left against a criterion appearing in the row on top.
The comparison scale is defined as follows: (given criteria A and B)
A and B are equally important, insert 1;
A is weakly more important than B, insert 3;
A is strongly more important than B, insert 5;
A is demonstrably or very strongly more important than B, insert 7;
A is absolutely more important than B, insert 9;
in the position (A,B) where the row of A meets the column of B.

A criterion is equally important when compared with itself, so where the row of A and column of A meet in position (A,A) insert 1. Thus the main diagonal of a matrix must consist of 1's. Insert the appropriate reciprocal 1, 1/3, ..., 1/9 where the column of A meets the row of B, i.e. position (B,A) for the reverse comparison of B with A. The numbers 2, 4, 6, 8 and their reciprocals are used to facilitate compromise between slightly different judgments.
It frequently happens that a matrix, after it has been filled with numbers, is inconsistent.
In general, what is meant by being consistent is that from a basic amount of raw data, all other data can be logically deduced from it.
Example:
if criterion A is 3 times more dominant than criterion B and criterion A is 6 times more dominant than criterion C than it should follow that criterion B is 2 times more dominant than criterion C.
However, sometimes it is very difficult to be consistent. Saaty shows that inconsistency, when using the nine-point comparison scale, is not a very big problem so one doesn't have to worry about this.
The next step consists of the computation of a vector of priorities from the given matrix.
In mathematical terms the principal eigenvector is computed, and when normalized becomes the vector of priorities. The computation of the eigenvector will not be explained here. The meaning of an eigenvector is that it provides a measure of each criterion's relative importance to the decision maker in the light of the overall objective.

Appendix 7

Frequencies half year demand of class X parts

This appendix gives a more detailed view of the demand for spare parts of the classes AX, BX and CX.

Half year demand	Frequency	Cum % cons	%cons		
10-20	97	4.9	4.9		
20-30	97	12.8	7.9		
30-40	47	18.3	5.5		
40-50	34	23.4	5.1		
50-60	29	28.7	5.3		
60-70	18	32.5	3.8		
70-80	19	37.3	4.8		
80-90	9	39.9	2.6		
90-100	14	44.3	4.4		
100-150	39	60.4	16.1		
150-200	17	70.0	9.6	Total	29551
200-250	11	78.0	8.0	Average	66.0
250-300	6	83.6	5.6	Median	36.5
>300	11	100.0	16.4	Range	12-670
	448		100	St. dev.	81.6

Table 1 Frequency table

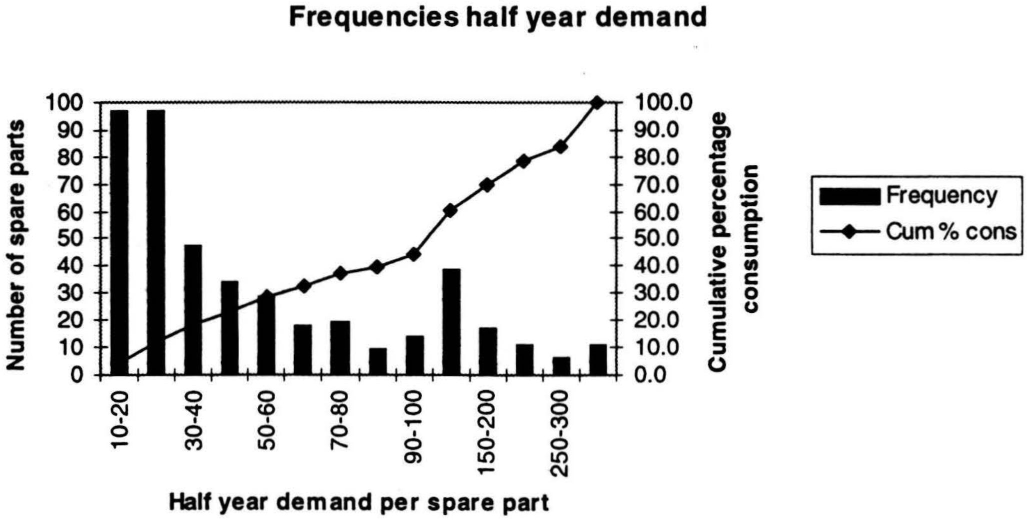


Figure 1 Frequencies half year demand of class X parts

Appendix 8

Digital partnumbers and part descriptions

Compaq partnumber	Digital partnumber	Description
Repairables		
199643001	FE-00878-01	DRIVE, TRAY 2.1GBWD, SCSI
142261001	FD-M9524-01	BATTERY
160788201	FE-CCA0H-QL	DRIVE, FLOPPY, 3.50" 1.44MB
148290002	FD-M5189-01	(IC), PROCESSOR, P566, FPF
213546001	FD-M8493-01	BOARD, SYSTEM, 75/90, 1M VRAM-LT
144850003	FD-W16HL-01	BASE, CPU, CONCERTO 4/33
Consumables		
169052001	FE-02044-01	POWER SUPPLY, 325W, 3.3V, PFC, LP
106854001	FD-56829-C5	MANUAL, QRG, (QTY 5)
141189001	FE-00938-01	MOUSE
173066001	FD-W171V-01	BRACKET, LOCK MECH
213564003	FD-ZZZI3-01	BATTERY PK-NIMH-3.3AL5K
147050001	FD-M4948-01	ENCLOSURE, DISPLAY

Table 1 Digital partnumber and part description

Appendix 9

Values of selected parts

Repairables			
Partnumber	6 months usage (in pieces)	Price ($)	Weight (kg)
199643001	293	1100.00	1.32
142261001	1	366.00	3.00
160788201	670	89.00	0.68
148290002	5	1200.00	0.22
213546001	395	1800.00	0.62
144850003	80	27.00	0.70

Consumables			
Partnumber	6 months usage (in pieces)	Price ($)	Weight (kg)
169052001	40	201.00	2.10
106854001	27	22.00	1.32
141189001	258	10.00	0.24
173066001	150	10.00	0.20
213564003	193	120.00	0.84
147050001	163	22.00	0.44

Table 1 Part values

General:
The average price and weight of a repairable part are respectively $717 and 1.24 kg.
The average price and weight of a consumable part are respectively $77.64 and 0.60 kg.
Interesting is the fact that the average price of *functional* consumables is $103.89 and of *cosmetic* consumables is $49.05.
Large variations exists with respect to the price (see figure 1) and weight.

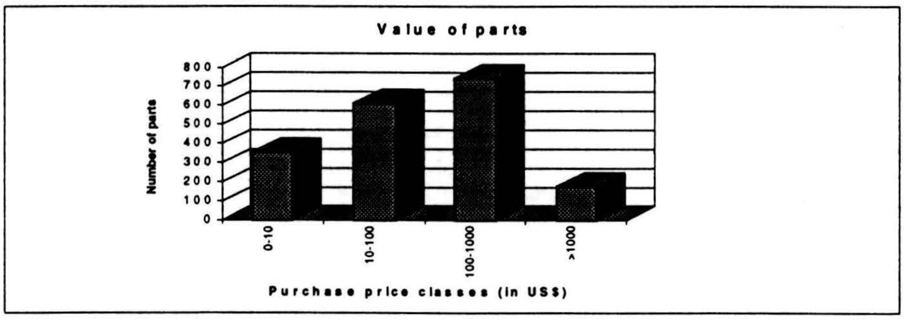


Figure 1 Value of parts

Appendix 10

Consumption of <u>all</u> spare parts per country

Country	4 months consumption	Percentage	Cum. Percentage
United Kingdom*	9563	41.29	41.29
Switzerland	3657	15.79	57.08
Netherlands	2186	9.44	66.52
Germany	2086	9.01	75.53
Finland	1251	5.40	80.93
Sweden	999	4.31	85.24
France	832	3.59	88.83
Austria	814	3.51	92.34
Italy	740	3.20	95.54
Belgium	687	2.97	98.51
Spain	231	1.00	99.51
Portugal	60	0.26	99.77
Hungary	37	0.16	99.93
Denmark	18	0.08	100.00
Norway	0	0	100.00

Table 1 Consumption per country

In all countries, except for the UK, the consumption is based on both warranty <u>and</u> contract calls. The consumption in the UK is based on warranty calls only.

Appendix 11

Consumption of <u>selected</u> spare parts in top four countries

Partnumber	U.K.*	Switzerland	Netherlands	Germany
Repairables				
199643001 *neglected*	45	34	7	30
160788201	163	56	33	76
148290002	0	1	0	0
213546001	87	51	34	0
144850003	18	16	1	0

Partnumber	U.K.*	Switzerland	Netherlands	Germany
Consumables				
169052001	6	4	0	9
106854001	19	0	0	2
141189001	58	33	37	6
173066001	0	0	150	0
213564003	48	57	14	0
147050001	31	27	12	0

Table 1 Consumption figures (four months) per country

Appendix 12

Consumption figures per month per country (repairables)

Repairables					
Partnumber	Month	United Kingdom	Switzerland	Netherlands	Germany
199643001	October '96	16	11	0	8
	November '96	9	3	0	10
	December '96	16	7	3	8
	January '97	4	13	4	4
142261001	October '96	*neglected*			
	November '96				
	December '96				
	January '97				
160788201	October '96	42	13	9	23
	November '96	25	20	8	20
	December '96	56	12	12	19
	January '97	40	11	4	14
148290002	October '96	0	1	0	0
	November '96	0	0	0	0
	December '96	0	0	0	0
	January '97	0	0	0	0
213546001	October '96	23	13	11	0
	November '96	16	18	4	0
	December '96	33	12	11	0
	January '97	15	8	8	0
144850003	October '96	8	2	1	0
	November '96	3	7	0	0
	December '96	3	6	0	0
	January '97	4	1	0	0

Table 1 Consumption figures per month

Consumption figures per month per country (consumables)

Consumables					
Partnumber	Month	United Kingdom	Switzerland	Netherlands	Germany
169052001	October '96	1	1	0	1
	November '96	2	0	0	1
	December '96	3	2	0	5
	January '97	0	1	0	2
106854001	October '96	0	0	0	0
	November '96	0	0	0	0
	December '96	0	0	0	0
	January '97	19	0	0	2
141189001	October '96	13	7	4	0
	November '96	18	9	9	1
	December '96	17	14	13	5
	January '97	10	3	11	0
173066001	October '96	0	0	0	0
	November '96	0	0	0	0
	December '96	0	0	0	0
	January '97	0	0	150	0
213564003	October '96	10	21	1	0
	November '96	18	12	3	0
	December '96	11	13	7	0
	January '97	9	11	3	0
147050001	October '96	9	9	2	0
	November '96	6	8	3	0
	December '96	11	7	2	0
	January '97	5	3	5	0

Table 2 Consumption figures per month

Appendix 13

Response times of contracted models (products) in the Netherlands

The response times in the contracts can be divided into four categories: '2 hours', '4 hours', '8 hours' and 'next day'.
Table 1 depicts the number of contracted models of which information was found and depicts the distribution of the response times among the four categories. In these categories the total number of products (pieces) is depicted for which the response time counts. The last row depicts the distribution of response times.

Partnumber	Number of contracted models	Number of contracted models found in system	2 hours	4 hours	8 hours	next day
Repairables						
199643001 *neglected*	15	15	24	207	0	0
160788201	23	15	3	978	0	35
148290002	not available	not available	n.a	n.a	n.a	n.a
213546001	2	1	0	0	0	18
144850003	1	1	0	0	0	1
Consumables						
169052001	35	32	49	205	1	1
106854001	not available	not available	n.a	n.a	n.a	n.a
141189001	50	35	17	89	0	113
173066001	29	18	6	40	0	40
213564003	2	1	0	0	0	18
147050001	1	1	0	0	0	4
			2 hours	4 hours	8 hours	next day
Percentage			5	82	0	13

Table 1 Response times of contracted products in the **Netherlands**

Appendix 14

Grouping spare parts

Group	Range (consumption) # pieces / 6 months	# Partnumbers	Tot. cons. (#) 6 months	Av. Price ($)
1	≥ 1000	69	125,885	140
2	500 - 1000	104	71,211	231
3	400 - 500	52	23,497	240
4	300 - 400	85	28,961	231
5	200 - 300	194	46,711	271
6	100 - 200	470	65,594	322
7	50 - 100	777	53,780	310
8	10 - 50	3,613	78,088	312
9	3 - 10	5,407	27,199	407
10	1 - 3	2,719	3,742	407
11	0	15,562	0	493
Total		29,052	524,668	

Table 1 30,000 spare parts divided into groups

Table 1 depicts the division of the spare parts into eleven groups according to the European consumption in pieces during a period of six months (September 1996 - February 1997).

Appendix 15

A: Description of the spreadsheet

In this part of appendix 15 the spreadsheet, which is depicted in part B, is described.
The spreadsheet 'FILLLOS_real' is devided into two worksheets. The first worksheet, called 'fast movers per SSP', has been developed to calculate *stock levels*, the *Level Of Service* and the *average lead time to the customers* with respect to fast movers. The second worksheet, called 'Groups' has been developed to calculate *stock levels*, the *Level Of Service* and the *average lead time to the customers* with respect to slow movers. Next to that, the second worksheets also determines the *stocking location* with respect to the slow movers. In order to understand the way the spreadsheet executes the calculations, one has to pay attention to the theory described in section 6.3 and 6.4.
Two important assumptions in the spreadsheet are:

- The demand for the spare parts is a Poisson process;
- The order quantity for the batch size to replenish the SSPs (by Nijmegen) and to replenish Nijmegen (by the vendors) equals one.

The spreadsheet is meant for parts for which has already been decided to stock them somewhere. In other words, the question: "which parts have to be stocked?", has to be answered in advance (see section 5.6). At this moment it is assumed that all spare parts (approximately 30,000), mentioned in appendix 14, must be stocked.

<u>Worksheet: 'fast movers per SSP'</u>
With respect to the fast movers it is assumed that these parts are always stocked in every SSP and that the replenishment of the SSPs is taken care of by Nijmegen, which is the central European stock location.
As this worksheet is meant for fast moving spare part, it is necessary to determine in advance which parts are fast movers. For now it has been decided that 173 spare parts, assigned to the first two groups in appendix 14, are fast movers. Of course management could decide otherwise at a later time.

In the first four columns of the worksheet data, concerning *partnumber*, *price*, *average monthly demand per SSP* and the *percentage of total consumption* (ptc), has to be put in for every (fast moving) spare part. The data of the present worksheet (see part B of this appendix) is based on a period of six months (September 1996-February 1997). The average monthly demand per SSP for a particular spare part is calculated by dividing the European demand during this period by the number of months (six) and the number of SSPs in Europe (eighty). The ptc is calculated by dividing the European demand during the six months for a particular spare part by the total European demand during the six months for all (approximately 30,000) spare parts. This fraction is multiplied by 100% to get the percentage.
Because these data are input for the worksheet, the calculations have to be executed in advance.

After the data for all fast movers has been entered, the value of <u>seven</u> parameters has to be inserted into the worksheet. The position of where these values have to be inserted is indicated by shaded cells. In the particular shaded cells a note explains the parameter which has to be inserted.

The seven parameters are:
1. Average replenishment time in **months** from Nijmegen to the SSPs;
2. Minimum required fill-rate at the SSPs;
3. Number of SSPs;
4. Average replenishment time in **months** from vendors to Nijmegen;
5. Minimum required fill-rate at Nijmegen;
6. Average lead time in **days** from the SSPs to the 'customers';
7. Average lead time in **days** from Nijmegen to the 'customers'.

The fill-rate is defined as the fraction of demands that are met from stock on the shelf. Assigning values to the two fill-rates is a management decision, which is based on what management decides to be the minimum fill-rate, that is still acceptable for the fast movers. The number of SSPs, put in as a parameter in the worksheet, must be in accordance with the number of SSPs used in the preceding calculations (see the previous paragraph).

The meaning of the parameters, used in the worksheet, is explained by figure 1.

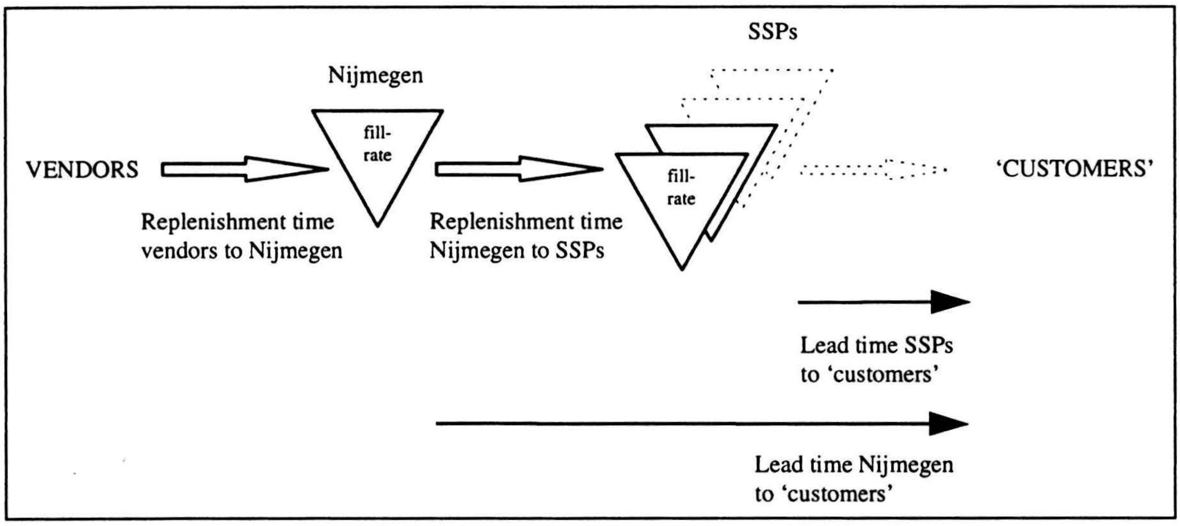


Figure 1 Explanation of parameters used in worksheet 'fast movers per SSP'

After the values of the parameters have been put in, the worksheet calculates the recommended stock levels for the spare parts in the SSPs (column W). This column depicts the stock level which must be maintained for a particular spare part in every SSP. The calculation is based on the average demand per month per SSP (column C), the average replenishment time from Nijmegen to the SSPs (parameter 1), the minimum fill-rate at the SSPs (parameter 2) and the minimum fill-rate at Nijmegen (parameter 5). The minimum fill-rate at Nijmegen is also included in this calculation, because this fill-rate determines the fraction of orders from Nijmegen to the SSPs, which is replenished according to the replenishment time from Nijmegen to the SSPs (parameter 1). With respect to the fraction of replenishment orders that cannot be met from the shelf in Nijmegen (1- fill-rate $_{\text{Nijmegen}}$), it is assumed that the replenishment time to the SSPs equals the sum of parameter 1 and parameter 4.

Based on the recommended stock levels per SSP, the worksheet calculates the total number of pieces that should be stocked in the SSPs (column X) and the total investment in k$ (column Y). Column Z depicts the contribution to the overall Level of Service per fast mover. This value results from the multiplication of the ptc (column D) and the fill-rate that goes along with the recommended stock level (columns G to V).

Column AA depicts the replenishment stock at Nijmegen, that is needed to replenish the SSPs. The calculation is based on the average total European demand per month, the average replenishment time from the vendors to Nijmegen (parameter 4) and the minimum fill-rate at Nijmegen (parameter 5). It is assumed that the vendors always carry stock, which means that the replenishment time (parameter 4) is not influenced by a fill-rate at the vendors.
The investment in k$ in Nijmegen ('column AA' x 'column B') is depicted in column AB.

To calculate the average lead time to the 'customers' (= sum of values in column AC) parameter 6 and parameter 7 are used. The value in column AC is calculated as follows: first the weighted lead time from the SSPs to the 'customers' and the weighted lead time from Nijmegen to the 'customers' are calculated. The former is the multiplication of parameter 6 and the fill-rate at the SSPs (which results from the recommended stock level). The latter is the multiplication of parameter 7 and the 'miss'-rate at the SSPs (= 1 - fill-rate). Next, the sum of these two weighted lead times is multiplied by the ptc (column D) and then divided by the total ptc (= sum of column D).
Finally, the sum of column AC is equal to the average lead time to the 'customers'.

The results of all calculations are summarized in column F, at the top of the worksheet. This summary depicts the total number of pieces (in the SSPs and in Nijmegen) that have to be stocked, the total investment in k$, the total contribution to the overall Level Of Service and the average lead time to the 'customers'.
It should be noticed that the total contribution to the overall Level Of Service must not be compared to the maximum of 100%, but must be compared to the total ptc (= sum of column D). More about the Level Of Service will be mentioned after the description of the worksheet 'Groups'.

Worksheet: 'Groups'
In contradiction to the fast movers, slow movers are not always stocked in every SSP. It depends on the average monthly demand, whether a part is stocked in a SSP, in a central stocking room per country or even in the European stocking room in Nijmegen. Generally, the lower the demand, the more centrally spare parts are being stocked. Of course, the lower (demand) limit for stocking in every SSP and the lower (demand) limit for stocking centrally per country has to be determined by management. The worksheet 'Groups' allows management to insert two parameters, which directly determine the location of where the spare parts should be stocked.
As this worksheet is meant for slow movers, it is necessary to determine in advance which parts are slow movers. For now it has been decided that the parts assigned to group 3 to group 11, mentioned in appendix 14, are slow movers.

In the first six columns of the worksheet data, concerning *group number*, *number of spare parts per group*, *average price per part*, *average monthly demand per part per SSP*, *average monthly demand per part per country* and the *ptc*, has to be entered for every group. The data of the present worksheet (see part B of this appendix) is again based on the period: September 1996 - February 1997.
The data for the first three columns can be found in appendix 14. The average monthly demand per spare part per SSP is calculated by dividing the total consumption in six months per group (see appendix 14) by the number of spare parts per group, the number of months (six) and the number of SSPs (eighty). To calculate the average monthly demand per spare part per country the number of countries (sixteen) must be used instead of the number of SSPs.
The ptc per group is calculated by dividing the total consumption per group by the total consumption of all (approximately 30,000) spare parts. This fraction is multiplied by 100% to get the percentage.

Because these data are input for the worksheet, the calculations have to be executed in advance.

After the data for all groups of slow movers have been put in, the value of eleven parameters has to be inserted into the worksheet. The position of where these values have to be inserted is indicated by shaded cells. In the particular shaded cells a note explains the parameter which has to be inserted. The eleven parameters are:

1. Average replenishment time in **months** from Nijmegen to the SSPs;
2. Minimum required fill-rate at the SSPs;
3. Minimum required fill-rate at Nijmegen;
4. Number of SSPs;
5. Number of countries;
6. Minimum AMC (Average Monthly Consumption) per country per spare part, for stocking parts in every SSP;
7. Minimum AMC per country per spare part, for stocking parts centrally in countries;
8. Replenishment time in **months** from vendors to Nijmegen;
9. Average lead time in **days** from SSPs to 'customers';
10. Average lead time in **days** from (central) country stocking point to 'customers';
11. Average lead time in **days** from Nijmegen to 'customers'.

The fill-rate is defined as the fraction of demands that are met from stock on the shelf. Assigning values to the fill-rates at the SSPs (parameter 2) and Nijmegen (parameter 3) is a management decision, which is based on what management decides to be the minimum fill-rate, that is still acceptable for slow movers. As can be seen in the worksheet in part B, it is possible to insert the fill-rates for every individual group of spare parts. This is done, in order to enable Digital to strive for different service levels for different groups of spare parts. Generally, the slowest moving spare parts will get the lowest service levels.
The number of SSPs and the number of countries, put in as parameters in the worksheet, must be in accordance with the numbers used in the preceding calculations.

Parameter 6 and parameter 7 are respectively the lower (demand) limit for stocking parts in every SSP and the lower (demand) limit for stocking parts centrally per country. This means that parts with an AMC per country, which falls between the two limits, are stocked centrally per country and parts with an AMC per country, less than parameter 7, are stocked in Nijmegen. Parts with an AMC per country, higher than parameter 6, are stocked in every SSP.
The meaning of the other parameters, used in the worksheet, is explained by figure 2.

After the values of the parameters have been put in, the worksheet calculates the recommended stock levels for the spare parts (column AA). Furthermore, the worksheet shows the location of where the parts should be stocked (column AB). The location depends on parameter 6 and parameter 7. Given the location the recommended stock levels are calculated. Thus, column AA and column AB are mutual depended. Since, if the location is 'Nijmegen', the recommended stock level in Nijmegen must be based on the average monthly European demand, the replenishment time from the vendors to Nijmegen (parameter 8) and the minimum fill-rate at Nijmegen (parameter 3). However, if the location is 'every SSP', the recommended stock level in the SSPs must be based on the AMC per SSP, the replenishment time from Nijmegen to the SSPs (parameter 1), the minimum fill-rate at the SSPs (parameter 2) and the minimum fill-rate at Nijmegen (parameter 3). The reason for also taking the fill-rate at Nijmegen into the calculation has already been explained (see worksheet: 'fast movers per SSP'). If the location is 'central per country', the minimum fill-rate of parameter 2 is used and it is assumed that the replenishment time from Nijmegen to the stocking location is equal to parameter 1. In this case the recommended stock level is based on the AMC per country, the replenishment time (parameter 1), the minimum fill-rate at the SSPs (parameter 2) and the minimum fill-rate at Nijmegen (parameter 3).

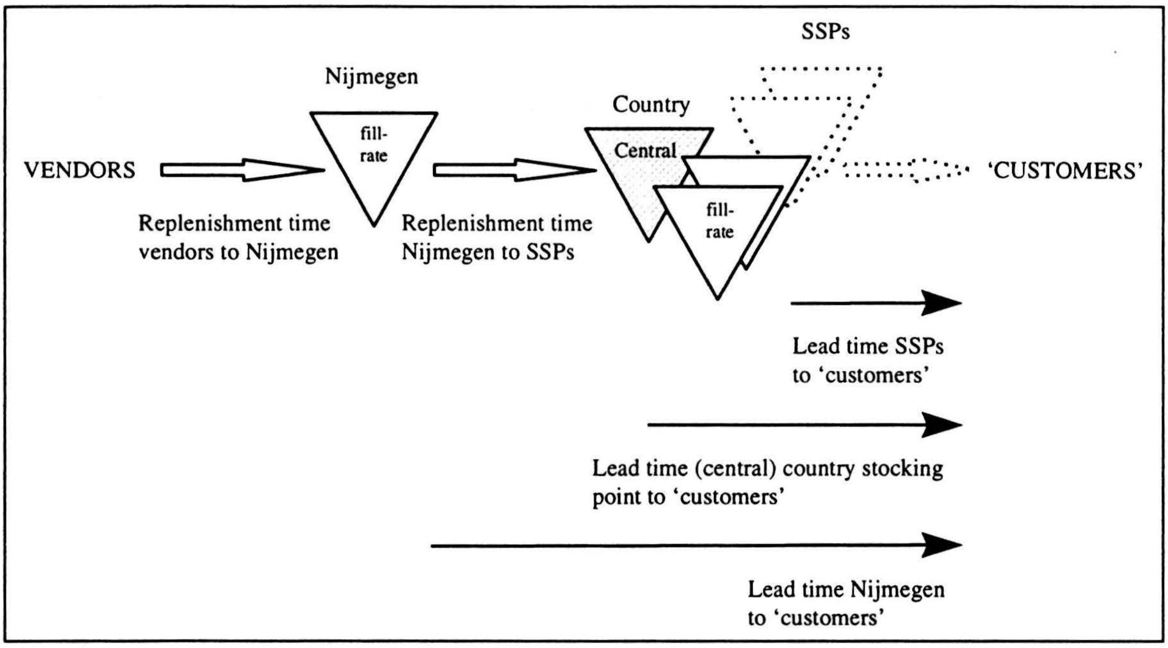


Figure 2 Explanation of parameters used in worksheet 'Groups'

Based on the recommended stock levels and the stocking location the worksheet calculates the total number of pieces that should be stocked (column AC) and the total investment in k$ (column AD). In the same way, as has been described before (worksheet: 'fast movers per SSP'), the contribution to the overall Level Of Service is calculated (column AE).

Column AF depicts the replenishment stock at Nijmegen, that is needed to replenish the SSPs or the (central) country stocking room. Of course, no replenishment stock is needed if the parts are already stocked in Nijmegen. The calculation of the replenishment stock has already been described (see worksheet: 'fast movers per SSP'). The investment in k$ in Nijmegen is depicted in column AH.

In order to calculate the average lead time to the 'customers' (= sum of values in column AI) parameter 9, 10 and 11 are used. The value in column AI depends on the stocking location and is calculated as follows: If the location is 'every SSP', the weighted lead time from the SSPs to the 'customers' and the weighted lead time from Nijmegen to the 'customers' are calculated. The former is the multiplication of parameter 9 and the fill-rate at the SSPs (which results from the recommended stock level (columns K to Z)). The latter is the multiplication of parameter 11 and the 'miss'-rate at the SSPs. Next, the sum of these two weighted lead times is multiplied by the ptc (column F) and then divided by the total ptc (= sum of column F).
If the location is 'central per country', the weighted lead time from the (central) country stocking point to the 'customers' and the weighted lead time from Nijmegen to the 'customers' are calculated. The former is the multiplication of parameter 10 and the fill-rate at the stocking point (which goes along with the recommended stock level (column K to Z)). The latter is the multiplication of parameter 11 and the 'miss'-rate at the (central) country stocking point. Next, the sum of these two weighted lead times is multiplied by the ptc (column F) and then divided by the total ptc (= sum of column F).
If the location is 'Nijmegen' the value in column AI is calculated by multiplying parameter 11 with the ptc and then dividing it by the total ptc.

Finally, the sum of column AI is equal to the average lead time to the 'customers'.

The results of all calculations are summarized in column J. This summary depicts the total number of pieces that should be stocked, the total investment in k$, the total contribution to the overall Level Of Service and the average lead time to the 'customers'.
Again it should be noticed that the total contribution to the overall Level Of Service must not be compared to the maximum value of 100%, but must be compared to the total ptc (= sum of column F).

After both worksheets have been applied, the results can be summarized. Except for the total Level Of Service, it is expected that the sum of the individual results requires no further explanation.
The sum of the 'total contribution to the overall Level Of Service' of the worksheet 'fast movers per SSP' and the worksheet 'Groups' is equal to the overall Level Of Service. In terms of the formulas described in section 6.3 and section 6.4 the total Level Of Service could be described as:

$$LOS = \sum_{p=1}^{173} ptc_p * FR_p + \sum_{G=3}^{11} ptc_G * FR_G \qquad (1)$$

The final Level Of Service (formula 1) can be compared to the pre-specified Level Of Service. If the Level Of Service is too low, parameters can be changed in the worksheets, in order to increase the Level Of Service. The reverse counts, if the Level Of Service is too high. Parameters can be changed then, in order to decrease the Level Of Service and the investment in k$.

At the end of this part of the appendix a few remarks are made:
1.
The worksheets are developed in a way that they can easily be extended to a larger number of parts (fast movers) or to a larger number of groups (slow movers). In that case the columns G to AC of the worksheet 'fast movers per SSP' can be copied downwards, up to the row where the data of the last fast mover have been inserted. The same counts for the worksheet 'Groups', where the columns K to AI can be copied downwards, up to the row where the data of the last group of slow movers have been inserted.
However, one must always calculate the sum of the ptc's (column D in the worksheet 'fast movers per SSP' and column F in the worksheet 'Groups') and make sure that the cell, containing the total ptc, is referred to in the formula in column AC ('fast movers per SSP') and column AI ('Groups').
Furthermore, to be able to use the summary of the calculations in both worksheets, the formulas in this summary must refer to the appropriate column-totals.

2.
In both worksheets resource sharing between SSPs is not taken into account. This would have made the worksheets very complicated. However, in practice resource sharing is possible within the countries. In general, resource sharing will have a positive effect on the Level Of Service and therefore, the recommended stock levels, calculated in the worksheets, will be sufficient for the calculated Level Of Service. In fact, the real Level Of Service will even be higher than the calculated Level Of Service.
Part B of this appendix depicts the worksheet 'fast movers per SSP' and the worksheet 'Groups'.

B: Spreadsheet; worksheet 'fast movers per SSP' (Scenario 80-0-20)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC
1	Fast movers				Requirement lead time	Stock level	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Recommended	Tot. number of	Investm. in k$	LOS	Requirement	Investm. in k$	Weighted av. lead time noticed
2	Partnumber	Price($)	Av. dem.	pk (%)	0.1	Cum. in (k)		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	stock level	parts in SSPs	in SSPs		stock Nijm. (#)	in Nijmegen	by a customer (see total)
3	4K421-AA	35.0	11.27	1.03			0.000	0.306	0.669	0.883	0.868	0.993	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	4	320	11.2	0.998	501	17.5	0.016
4	RX23X-AA	17.1	10.15	0.93	The table depicts the fill-rate with		0.000	0.344	0.712	0.907	0.977	0.995	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	4	320	5.5	0.907	453	7.7	0.014
5	29-28288-02	123.3	9.45	0.86	respect to a particular spare		0.000	0.371	0.738	0.921	0.981	0.996	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	4	320	38.5	0.849	424	52.3	0.012
6	30-43478-02	93.5	8.83	0.81	part, in case of different stock		0.000	0.396	0.763	0.933	0.985	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	4	320	29.6	0.795	387	37.1	0.011
7	54-24486-01	243.6	7.25	0.66	levels		0.000	0.467	0.822	0.958	0.992	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	58.5	0.636	330	80.4	0.010
8	4K401-AT	28.9	6.97	0.64			0.000	0.481	0.833	0.962	0.993	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	8.2	0.613	318	8.3	0.010
9	TH3XD-01	69.0	6.14	0.56	Min. fill-rate SSPs	0.96	0.000	0.525	0.863	0.972	0.996	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	16.6	0.546	283	19.5	0.008
10	PCXAS-AD	6.4	6.06	0.55			0.000	0.529	0.866	0.973	0.996	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	1.5	0.540	279	1.8	0.008
11	70-26536-02	128.2	6.06	0.55	Number of SSPs	80	0.000	0.529	0.866	0.973	0.996	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	30.8	0.539	276	35.8	0.008
12	VSXXX-GA	13.9	5.91	0.54			0.000	0.537	0.871	0.975	0.996	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	3.3	0.527	273	3.8	0.008
13	30-42709-01	22.5	5.65	0.52	Requirement lead time vendors		0.000	0.552	0.880	0.978	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	5.4	0.506	262	5.9	0.008
14	FD-W001F-01	5.8	5.66	0.52	to Nijm. (months)	0.50	0.000	0.552	0.880	0.978	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	1.4	0.506	262	1.5	0.008
15	70-24577-02	108.2	5.54	0.51			0.000	0.559	0.884	0.979	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	26.0	0.466	257	27.8	0.007
16	PC7XS-AA	5.4	5.54	0.51	Min. fill-rate Nijm.	0.99	0.000	0.559	0.884	0.979	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	1.3	0.466	257	1.4	0.007
17	4K401-AP	30.0	4.86	0.45			0.000	0.598	0.906	0.985	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	7.2	0.441	229	6.9	0.006
18	PCXBV-PE	213.6	4.72	0.43	Av. lead time SSP		0.000	0.609	0.911	0.986	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	51.3	0.426	221	47.2	0.006
19	54-24068-01	235.6	4.68	0.43	to 'customer' (days)	0.5	0.000	0.612	0.912	0.986	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	56.5	0.422	220	51.8	0.006
20	RZ28M-VA	499.1	4.47	0.41			0.000	0.625	0.919	0.988	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	119.8	0.404	211	105.3	0.006
21	DE205-AC	39.8	4.16	0.38	Av. lead time Nijmegen		0.000	0.646	0.928	0.990	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	9.5	0.377	197	7.8	0.006
22	PCXCV-SA	199.5	4.10	0.38	to 'customer' (days)	2.5	0.000	0.650	0.930	0.990	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	47.9	0.372	194	38.7	0.005
23	RZ26B-VA	786.5	4.03	0.37			0.000	0.655	0.932	0.991	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	188.8	0.365	191	150.2	0.005
24	RZ28-VA	488.2	3.93	0.36			0.000	0.662	0.935	0.991	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	117.2	0.357	187	91.3	0.005
25	PCXBV-TD	299.0	3.67	0.34	Totals		0.000	0.680	0.942	0.993	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	71.5	0.333	175	52.2	0.005
26	29-28415-01	8.0	3.66	0.33	Parts in SSPs	30160	0.000	0.681	0.943	0.993	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	1.9	0.332	175	1.4	0.005
27	RE45B-E	138.0	3.60	0.33	Parts in Nijmegen	20257	0.000	0.685	0.944	0.993	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	32.6	0.327	172	23.4	0.005
28	PCXBV-SA	234.0	3.59	0.33		50417	0.000	0.686	0.945	0.993	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	56.2	0.326	172	40.2	0.004
29	29-25102	9.0	3.54	0.32			0.000	0.690	0.946	0.994	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	2.2	0.322	170	1.5	0.004
30	70-32162-01	38.7	3.29	0.30	k$ in SSPs	5743.0	0.000	0.708	0.952	0.995	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	6.2	0.287	159	6.2	0.005
31	29-25104	13.7	3.28	0.30	k$ in Nijmegen	3405.3	0.000	0.708	0.953	0.995	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.2	0.286	158	2.2	0.005
32	RZ28L-E	306.0	3.25	0.30		9148.2	0.000	0.711	0.953	0.995	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	48.8	0.284	157	47.6	0.005
33	29-28287-01	12.4	3.20	0.29			0.000	0.714	0.955	0.995	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.0	0.280	155	1.9	0.005
34	PCXRA-AF	141.0	3.11	0.28	Contribution to LOS	36.8	0.000	0.721	0.957	0.995	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	22.6	0.272	151	21.3	0.004
35	30-36608-03	331.0	3.06	0.28			0.000	0.726	0.958	0.996	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	53.0	0.268	148	49.0	0.004
36	4K401-AG	28.0	3.01	0.28	Av. lead time in days noticed		0.000	0.729	0.959	0.996	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	4.2	0.264	147	3.8	0.004
37	29-29971-01	99.4	2.88	0.27	by customers	0.541	0.000	0.732	0.960	0.996	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	15.9	0.262	145	14.4	0.004
38	54-23170-AA	81.6	2.93	0.27			0.000	0.735	0.961	0.996	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	13.1	0.257	143	11.7	0.004
39	PCXRA-AI	138.0	2.84	0.26			0.000	0.742	0.963	0.996	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	22.1	0.250	138	19.2	0.004
40	PCXLA-GS	12.2	2.83	0.26			0.000	0.743	0.964	0.996	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.9	0.250	138	1.7	0.004
41	30-44823-02	300.0	2.83	0.26			0.000	0.743	0.964	0.996	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	48.0	0.249	138	41.4	0.004
42	DECXM-AA	35.6	2.83	0.26			0.000	0.743	0.964	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	5.7	0.249	138	4.9	0.004
43	29-32545-01	25.9	2.82	0.26			0.000	0.744	0.964	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	4.1	0.248	138	3.6	0.004
44	BC13X-10	14.0	2.76	0.25			0.000	0.749	0.965	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.2	0.244	135	1.9	0.004
45	29-28281-01	12.2	2.73	0.25			0.000	0.751	0.966	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.0	0.242	134	1.6	0.004
46	DE450-CA	33.6	2.67	0.24			0.000	0.756	0.967	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	5.4	0.236	131	4.4	0.004
47	T230-AX	400.0	2.66	0.24			0.000	0.757	0.968	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	64.0	0.235	131	52.4	0.004
48	12-23599-08	9.1	2.64	0.24			0.000	0.758	0.968	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.5	0.234	130	1.2	0.004
49	4K111-AA	30.5	2.59	0.24			0.000	0.762	0.969	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	4.9	0.230	128	3.9	0.004
50	TK86K-01	28.0	2.56	0.23			0.000	0.764	0.970	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	4.5	0.227	126	3.5	0.003
51	PCXLA-GE	12.2	2.55	0.23			0.000	0.765	0.970	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.9	0.226	126	1.5	0.003
52	4H406	40.3	2.45	0.23			0.000	0.773	0.972	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	8.4	0.218	122	4.9	0.003
53	29-29972-01	146.4	2.44	0.22			0.000	0.774	0.972	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	23.4	0.217	121	17.7	0.003
54	FD-44365-01	11.4	2.43	0.22			0.000	0.775	0.973	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.8	0.216	121	1.4	0.003
55	54-23603-02	104.0	2.43	0.22			0.000	0.775	0.973	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	16.6	0.216	121	12.6	0.003
56	VRC21-HA	1086.1	2.42	0.22			0.000	0.776	0.973	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	173.8	0.215	120	130.3	0.003
57	54-22703-07	96.9	2.38	0.22			0.000	0.779	0.974	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	15.5	0.212	118	11.4	0.003
58	54-24544-02	136.8	2.35	0.22			0.000	0.781	0.974	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	21.9	0.210	117	16.0	0.003
59	ME524-DE	28.8	2.29	0.21			0.000	0.786	0.975	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	4.6	0.204	114	3.3	0.003
60	PCXBV-SC	293.0	2.29	0.21			0.000	0.786	0.975	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	46.9	0.204	114	33.4	0.003
61	FR-PCP7H-AD	18.0	2.28	0.21			0.000	0.787	0.976	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.9	0.203	114	2.1	0.003
62	29-28277-01	8.9	2.27	0.21			0.000	0.789	0.976	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.4	0.203	113	1.0	0.003
63	TI Z07 BA	535.0	2.25	0.21			0.000	0.790	0.976	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	85.6	0.201	112	59.9	0.003
64	PCXAL-GE	16.5	2.18	0.20			0.000	0.795	0.977	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.6	0.195	109	1.8	0.003
65	30-41886-01	249.0	2.18	0.20			0.000	0.796	0.978	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	39.8	0.195	109	27.1	0.003
66	29-25918	86.8	2.17	0.20			0.000	0.796	0.978	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	13.9	0.194	108	9.5	0.003
67	DSRVB-AB	145.0	2.15	0.20			0.000	0.798	0.978	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	23.2	0.193	108	15.7	0.003
68	FD-74510-DL	51.0	2.10	0.19			0.000	0.802	0.979	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	8.2	0.188	106	5.4	0.003
69	4A7SS-A3	214.5	2.10	0.19			0.000	0.802	0.979	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	34.3	0.188	106	22.7	0.003
70	4N11X-AA	72.7	2.09	0.19			0.000	0.803	0.979	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	11.6	0.188	106	7.7	0.003
71	54-23644-04	162.5	2.09	0.19			0.000	0.803	0.979	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	26.0	0.187	106	17.1	0.003
72	TK50-AX	173.9	2.08	0.19			0.000	0.804	0.979	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	27.8	0.186	105	18.3	0.003
73	FR-PCP8H-AD	31.0	2.08	0.19			0.000	0.804	0.979	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	5.0	0.186	105	3.3	0.003
74	29-29328-01	211.1	2.04	0.19			0.000	0.807	0.980	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	33.8	0.183	103	21.7	0.003
75	PCXCV-AC	225.0	2.04	0.19			0.000	0.808	0.980	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	36.0	0.183	103	23.2	0.003
76	29-27880-01	110.8	2.01	0.18			0.000	0.810	0.981	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	17.7	0.180	102	11.3	0.003
77	PCXBY-DE	86.4	2.01	0.18			0.000	0.810	0.981	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	13.8	0.180	102	8.8	0.003
78	70-20589-01	70.0	1.99	0.18			0.000	0.811	0.981	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	11.2	0.179	101	7.1	0.003
79	RZ26B-VW	810.4	1.86	0.17			0.000	0.821	0.983	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	129.7	0.169	96	77.8	0.002
80	RF24M-E	132.1	1.87	0.17			0.000	0.822	0.983	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	21.1	0.169	95	12.6	0.002
81	30-41068-01	75.3	1.87	0.17			0.000	0.822	0.983	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	12.1	0.168	95	7.2	0.002
82	FE-MID11-QR	79.4	1.79	0.16			0.000	0.828	0.984	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	12.7	0.162	92	7.3	0.002
83	29-25818	56.6	1.78	0.16			0.000	0.830	0.985	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	9.0	0.160	91	5.1	0.002
84	70-26534-04	49.1	1.75	0.16			0.000	0.832	0.985	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	7.9	0.158	90	4.4	0.002
85	TI Z04 DA	750.0	1.75	0.16			0.000	0.833	0.985	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	120.0	0.157	90	67.5	0.002
86	30-41318-02	25.9	1.74	0.16			0.000	0.833	0.985	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	4.1	0.157	90	2.3	0.002
87	4K401-AS	26.0	1.72	0.16			0.000	0.835	0.986	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	4.2	0.155	88	2.3	0.002
88	70-19665-01	50.0	1.72	0.16			0.000	0.835	0.986	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	8.0	0.155	88	4.5	0.002
89	RZ26L-VA	300.0	1.72	0.16			0.000	0.835	0.986	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	48.0	0.155	88	26.4	0.002
90	PCXBV-T2	286.0	1.69	0.15			0.000	0.837	0.986	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	45.8	0.152	87	24.9	0.002
91	RDS3-A	281.0	1.68	0.15			0.000	0.838	0.986	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	45.0	0.152	87	24.5	0.002

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC
1	Fast movers				Replenishment time	Stocklevel	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Recommended	Tot. number of	Investm. in k$	LOS	Replenishment	Investm. in k$	Weighted av. lead time noticed
2	Partnumber	Price($)	Av. dem.	pk(%)	0.1	Due in (0-)		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	stock level	parts in SSPs	in SSPs		stock Nijm. (#)	in Nijmegen	by a custumer (see total)
92	70-20824-01	8.9	1.66	0.15			0.000	0.840	0.987	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.1	0.149	86	0.6	0.002
93	-RX10-AA	31.4	1.65	0.15			0.000	0.841	0.987	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	5.0	0.149	85	2.7	0.002
94	-LK411-AG	18.0	1.64	0.15			0.000	0.842	0.987	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.9	0.148	85	1.5	0.002
95	FE-PAE08-QX	15.0	1.63	0.15			0.000	0.843	0.987	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.4	0.147	84	1.3	0.002
96	54-22240-01	694.1	1.63	0.15			0.000	0.843	0.987	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	111.0	0.147	84	58.3	0.002
97	-H8575-A	6.1	1.60	0.15			0.000	0.846	0.987	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.0	0.144	83	0.5	0.002
98	30-43517-01	724.5	1.59	0.15			0.000	0.846	0.987	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	115.9	0.144	83	60.1	0.002
99	FE-PAE10-QS	151.0	1.59	0.15			0.000	0.846	0.988	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	24.2	0.144	83	12.5	0.002
100	FD-08842-DL	300.0	1.58	0.14			0.000	0.847	0.988	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	48.0	0.143	82	24.6	0.002
101	12-41768-03	16.8	1.56	0.14			0.000	0.849	0.988	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.7	0.141	81	1.4	0.002
102	FD-WLLJW-01	155.0	1.54	0.14			0.000	0.851	0.988	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	24.8	0.139	80	12.4	0.002
103	-PC7XY-DE	231.0	1.54	0.14			0.000	0.851	0.988	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	37.0	0.139	80	18.5	0.002
104	-TLZ08-BA	550.0	1.54	0.14			0.000	0.851	0.988	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	88.0	0.139	80	44.0	0.002
105	29-30058-01	143.5	1.53	0.14			0.000	0.851	0.988	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	23.0	0.139	80	11.5	0.002
106	54-21240-BA	55.8	1.53	0.14			0.000	0.852	0.988	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	8.9	0.138	80	4.5	0.002
107	-RE23R-E	102.5	1.52	0.14			0.000	0.853	0.989	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	16.4	0.137	79	8.1	0.002
108	30-40050-01	1100.0	1.51	0.14			0.000	0.854	0.989	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	176.0	0.136	79	86.9	0.002
109	FD-W07WP-01	36.6	1.50	0.14			0.000	0.854	0.989	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	5.7	0.136	78	2.8	0.002
110	FD-W06P7-01	36.3	1.48	0.14			0.000	0.856	0.989	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	5.8	0.134	78	2.8	0.002
111	-TLZ05-DX	700.0	1.46	0.13			0.000	0.858	0.989	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	112.0	0.132	77	53.9	0.002
112	-VRC21-W3	971.0	1.44	0.13			0.000	0.860	0.990	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	155.4	0.130	76	73.8	0.002
113	29-26089-	139.7	1.44	0.13			0.000	0.860	0.990	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	22.3	0.130	76	10.6	0.002
114	29-28293-01	16.8	1.43	0.13			0.000	0.860	0.990	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.7	0.130	75	1.3	0.002
115	FD-82195-DL	345.0	1.42	0.13			0.000	0.861	0.990	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	55.2	0.129	75	25.9	0.002
116	12-13097-	10.0	1.41	0.13			0.000	0.862	0.990	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.6	0.128	74	0.7	0.002
117	29-28272-01	7.1	1.40	0.13			0.000	0.863	0.990	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.1	0.127	74	0.5	0.002
118	FD-M7459-01	31.0	1.40	0.13			0.000	0.864	0.990	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	5.0	0.126	74	2.3	0.002
119	FD-WU8NT-01	10.4	1.39	0.13			0.000	0.864	0.990	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.7	0.126	74	0.8	0.002
120	-VRC20-HA	833.0	1.39	0.13			0.000	0.864	0.990	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	133.3	0.126	73	60.8	0.002
121	70-20881-01	90.1	1.38	0.13			0.000	0.865	0.990	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	14.4	0.125	73	6.6	0.002
122	FD-81721-DL	100.0	1.38	0.13			0.000	0.866	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	16.0	0.125	73	7.3	0.002
123	54-24012-01	237.0	1.38	0.13			0.000	0.866	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	37.9	0.125	73	17.3	0.002
124	30-44798-01	180.0	1.37	0.13			0.000	0.866	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	28.8	0.124	73	13.1	0.002
125	FD-85271-DL	350.0	1.37	0.13			0.000	0.866	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	58.0	0.124	73	25.6	0.002
126	FD-W07WR-01	47.8	1.37	0.13			0.000	0.866	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	7.7	0.124	73	3.5	0.002
127	-PCXAV-YB	568.5	1.37	0.13			0.000	0.866	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	90.8	0.124	72	40.8	0.002
128	-DEWQB-MA	267.5	1.37	0.13			0.000	0.866	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	42.8	0.124	72	19.3	0.002
129	FD-W06F1-01	8.7	1.35	0.12			0.000	0.868	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.6	0.122	71	0.7	0.002
130	-TLZ07-VA	607.3	1.34	0.12			0.000	0.868	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	97.2	0.122	71	43.1	0.002
131	12-18245-01	6.9	1.34	0.12			0.000	0.869	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.1	0.122	71	0.5	0.002
132	30-42093-01	199.1	1.34	0.12			0.000	0.869	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	31.9	0.121	71	14.1	0.002
133	FD-52781-01	81.4	1.34	0.12			0.000	0.869	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	13.0	0.121	71	5.8	0.002
134	FD-W0H8T-01	32.6	1.33	0.12			0.000	0.870	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	5.2	0.121	71	2.3	0.002
135	FD-80628-DL	250.0	1.32	0.12			0.000	0.871	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	40.0	0.120	70	17.5	0.002
136	29-31478-01	18.2	1.31	0.12			0.000	0.871	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.9	0.119	70	1.3	0.002
137	-DSRVF-B4	950.0	1.30	0.12			0.000	0.873	0.992	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	152.0	0.118	69	65.6	0.002
138	-TLZ07-CA	8.8	1.29	0.12			0.000	0.873	0.992	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.6	0.117	69	0.7	0.002
139	29-29006-01	14.8	1.28	0.12			0.000	0.874	0.992	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.4	0.116	68	1.0	0.002
140	17-03706-01	9.0	1.27	0.12			0.000	0.875	0.992	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.4	0.115	68	0.6	0.002
141	-TU58-K	13.5	1.27	0.12			0.000	0.875	0.992	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.2	0.115	68	0.9	0.002
142	FD-W06KR-01	8.7	1.26	0.12			0.000	0.876	0.992	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.6	0.114	67	0.7	0.002
143	30-45256-01	30.1	1.25	0.11			0.000	0.877	0.992	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	4.8	0.114	67	2.0	0.002
144	FD-W048A-01	14.3	1.24	0.11			0.000	0.878	0.992	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.3	0.112	66	0.9	0.002
145	29-32088-01	18.2	1.23	0.11			0.000	0.879	0.992	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.9	0.111	66	1.2	0.002
146	-VRC21-KA	961.6	1.22	0.11			0.000	0.880	0.992	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	153.9	0.111	65	62.5	0.002
147	-PCXCV-TW	254.0	1.22	0.11			0.000	0.880	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	40.6	0.110	65	16.5	0.002
148	29-27388-01	223.1	1.21	0.11			0.000	0.881	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	35.7	0.110	65	14.5	0.002
149	30-44170-01	42.3	1.21	0.11			0.000	0.881	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	6.8	0.110	65	2.7	0.002
150	29-28294-01	38.3	1.21	0.11			0.000	0.881	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	6.1	0.110	65	2.5	0.002
151	-TLZ07-DX	672.0	1.20	0.11			0.000	0.881	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	107.5	0.109	66	43.7	0.002
152	-TZ87-BX	2315.0	1.20	0.11			0.000	0.882	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	370.4	0.109	65	150.5	0.002
153	-PCXBV-KA	485.0	1.20	0.11			0.000	0.882	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	77.8	0.109	65	31.5	0.002
154	30-44935-01	35.0	1.18	0.11			0.000	0.883	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	5.6	0.107	64	2.2	0.001
155	FD-89794-DL	210.0	1.18	0.11			0.000	0.884	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	33.6	0.107	64	13.4	0.001
156	-RZ58-E	530.0	1.18	0.11			0.000	0.884	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	84.8	0.107	64	33.9	0.001
157	-PCXAL-GS	16.5	1.17	0.11			0.000	0.885	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.6	0.106	63	1.0	0.001
158	-PCXRA-AL	165.6	1.15	0.11			0.000	0.886	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	26.5	0.106	62	10.3	0.001
159	54-24588-02	136.3	1.15	0.10			0.000	0.887	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	21.8	0.104	62	8.4	0.001
160	-PCXCV-GE	183.0	1.14	0.10			0.000	0.887	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	29.3	0.104	62	11.3	0.001
161	-TLZ08-VA	600.0	1.13	0.10			0.000	0.888	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	96.0	0.103	61	36.6	0.001
162	FD-40777-01	67.8	1.13	0.10			0.000	0.889	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	10.8	0.102	61	4.1	0.001
163	70-28634-08	49.1	1.12	0.10			0.000	0.889	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	7.9	0.102	61	3.0	0.001
164	30-42081-01	85.6	1.11	0.10			0.000	0.890	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	13.7	0.101	60	5.1	0.001
165	29-28161-01	34.6	1.10	0.10			0.000	0.891	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	5.5	0.100	60	2.1	0.001
166	30-45289-02	40.0	1.09	0.10			0.000	0.892	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	6.4	0.099	60	2.4	0.001
167	-PCXLA-GT	12.2	1.09	0.10			0.000	0.892	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.9	0.099	59	0.7	0.001
168	-PCXAL-GG	16.5	1.09	0.10			0.000	0.892	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.6	0.099	59	1.0	0.001
169	-LK411-AT	18.0	1.08	0.10			0.000	0.892	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.9	0.099	59	1.1	0.001
170	54-24831-01	1032.8	1.08	0.10			0.000	0.893	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	165.2	0.098	59	60.9	0.001
171	30-44813-01	209.8	1.08	0.10			0.000	0.893	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	33.6	0.098	59	12.4	0.001
172	54-21225-EA	19.5	1.07	0.10			0.000	0.893	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	3.1	0.098	59	1.1	0.001
173	FD-W087F-01	92.4	1.07	0.10			0.000	0.894	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	14.8	0.097	58	5.4	0.001
174	29-32549-01	15.6	1.06	0.10			0.000	0.894	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.5	0.097	58	0.9	0.001
175	FD-41585-01	100.5	1.06	0.10			0.000	0.895	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	18.1	0.096	58	5.8	0.001
176																													
177				37.8																		Total		30180	5743.0	38.8	20257	3406.3	0.541

Worksheet 'Groups' (Scenario 80-0-20)

	A	B	C	D	E	F	G	H	I	J
1	Groups			BSP	Country		Minimum fill	Minimum fill	Repl. time time sup-BSPs (months)	Stocklevel
2	Group number	# partnumbers	Av. price ($)	Av. dem.	Av. dem.	ptc(%)	rate BSPs	rate Nijmegen	[illegible]	Due in (0-..)
3	3	52	246	0.941	4.710	4.40	[illegible]	[illegible]		
4	4	86	231	0.710	3.540	5.52	[illegible]	[illegible]	The table depicts the fill rate with	
5	5	104	271	0.502	2.506	8.80	[illegible]	[illegible]	respect to a particular group of	
6	6	470	322	0.281	1.464	12.80	[illegible]	[illegible]	spare parts, in case of different	
7	7	777	310	0.144	0.721	10.28	[illegible]	[illegible]	stock levels, stocked at three	
8	8	2613	312	0.048	0.226	14.80	[illegible]	0.75	possible locations.	
9	9	5407	407	0.010	0.062	5.10	[illegible]	[illegible]		
10	10	2710	407	0.003	0.014	0.71	[illegible]	[illegible]		
11	11	18662	480	0.000	0.000	0.00	[illegible]	[illegible]	Number of BSPs:	[illegible]
12										
13						62.42			Number of countries:	[illegible]
14										
15									Minimum AMC per country	
16									per spare part for stocking parts	
17									in every BSP:	[illegible]
18										
19									Minimum AMC per country	
20									per spare part for stocking parts	
21									centrally in countries:	[illegible]
22										
23									Replenishment time from vendors	
24									to Nijmegen (months):	[illegible]
25										
26									Av. lead time BSP to 'customer':	[illegible]
27									(days)	
28									Av. lead time (central) country	
29									stocking point to 'customer':	[illegible]
30									(days)	
31									Av. lead time Nijm. to 'customer':	[illegible]
32									(days)	
33										
34									Totals:	
35									Total number of parts:	200714
36										200714
37										
38									Total investment (k$):	64642.0
39										64642.0
40										
41									Contribution to LOS:	54.58
42										
43									Av. lead time in days noticed	
44									by customers:	1.22

	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
3	0.000	0.806	0.986	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
4	0.000	0.820	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
5	0.000	0.940	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
6	0.000	0.976	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
7	0.000	0.986	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
8	0.000	0.165	0.463	0.731	0.891	0.964	0.990	0.997	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000
9	0.000	0.680	0.934	0.991	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
10	0.000	0.894	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
11	0.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	AA	AB	AC	AD	AE	AF	AG	AH	AI
1	Recommended	Stocking	Total number of	Investment in	LOS	Replenishment	Total repl.	Investm. in k$	Weighted av. lead time noticed
2	stock level	location	parts on stock	stock (k$)		stock Nijm. (#)	stock Nijm. (#)	in Nijmegen	by a customer (see total)
3	1	every BSP	4100	898.4	4.00	52	2704	640.0	0.049
4	1	every BSP	6800	1570.0	6.12	41	3485	805.0	0.057
5	1	every BSP	15520	4230.9	8.44	31	8014	1629.8	0.080
6	1	every BSP	37600	12107.2	12.12	20	9400	3026.8	0.112
7	1	every BSP	62100	18200.6	10.10	12	9324	2600.4	0.087
8	4	Nijmegen	14452	4509.0	13.26	no repl. stock	0	0.0	0.566
9	2	Nijmegen	10814	4401.3	4.84	no repl. stock	0	0.0	0.207
10	1	Nijmegen	2718	1105.6	0.63	no repl. stock	0	0.0	0.026
11	1	Nijmegen	18662	7672.1	0.00	no repl. stock	0	0.0	0.000
12									
13		Total	189767	55640.9	54.58		30827	8001.6	1.22

Appendix 16

Tabel of the standard Normal distribution

Tabel van de standaardnormale verdeling.

Aangegeven is $P(\underline{z} > z)$. Dus $P(\underline{z} > 1{,}5) = 0{,}0668$.

Tweede decimaal van z

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0,0	.5000	.4960	.4920	.4880	.4840	.4801	.4761	.4721	.4681	.4641
0,1	.4602	.4562	.4522	.4483	.4443	.4404	.4364	.4325	.4286	.4247
0,2	.4207	.4168	.4129	.4090	.4052	.4013	.3974	.3936	.3897	.3859
0,3	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3483
0,4	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
0,5	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
0,6	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
0,7	.2420	.2389	.2358	.2327	.2296	.2266	.2236	.2206	.2177	.2148
0,8	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.1867
0,9	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.1611
1,0	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.1379
1,1	.1357	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.1170
1,2	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.0985
1,3	.0968	.0951	.0934	.0918	.0901	.0885	.0869	.0853	.0838	.0823
1,4	.0808	.0793	.0778	.0764	.0749	.0735	.0721	.0708	.0694	.0681
1,5	.0668	.0655	.0643	.0630	.0618	.0606	.0594	.0582	.0571	.0559
1,6	.0548	.0537	.0526	.0516	.0505	.0495	.0485	.0475	.0465	.0455
1,7	.0446	.0436	.0427	.0418	.0409	.0401	.0392	.0384	.0375	.0367
1,8	.0359	.0351	.0344	.0336	.0329	.0322	.0314	.0307	.0301	.0294
1,9	.0287	.0281	.0274	.0268	.0262	.0256	.0250	.0244	.0239	.0233
2,0	.0228	.0222	.0217	.0212	.0207	.0202	.0197	.0192	.0188	.0183
2,1	.0179	.0174	.0170	.0166	.0162	.0158	.0154	.0150	.0146	.0143
2,2	.0139	.0136	.0132	.0129	.0125	.0122	.0119	.0116	.0113	.0110
2,3	.0107	.0104	.0102	.0099	.0096	.0094	.0091	.0089	.0087	.0084
2,4	.0082	.0080	.0078	.0075	.0073	.0071	.0069	.0068	.0066	.0064
2,5	.0062	.0060	.0059	.0057	.0055	.0054	.0052	.0051	.0049	.0048
2,6	.0047	.0045	.0044	.0043	.0041	.0040	.0039	.0038	.0037	.0036
2,7	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0028	.0027	.0026
2,8	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.0019
2,9	.0019	.0018	.0018	.0017	.0016	.0016	.0015	.0015	.0014	.0014
3,0	.0013	.0013	.0013	.0012	.0012	.0011	.0011	.0011	.0010	.0010

Appendix 17

Sensitivity analysis of parameters used in the two worksheets

In the worksheets 'fast movers per SSP' and 'Groups' respectively seven and eleven parameters are used. To start the sensitivity analysis, it is attempted to put as much values as possible into the worksheets, that correspond with the present situation of the supply chain. With respect to some parameters, values that reflect a desirable future situation, or just arbitrarily chosen values have been put into the spreadsheet. The values that have been put in are summarized below: (values indicated by a *, are values that correspond with the present situation)

Worksheet: 'fast movers per SSP'

1. Average replenishment time in **months** from Nijmegen to the SSPs: 0.1*
2. Minimum required fill-rate at the SSPs: 0.98
3. Number of SSPs: 80*
4. Average replenishment time in **months** from vendors to Nijmegen: 0.5*
5. Minimum required fill-rate at Nijmegen: 0.99
6. Average lead time in **days** from the SSPs to the 'customers': 0.5*
7. Average lead time in **days** from Nijmegen to the 'customers': 2.5*

Worksheet: 'Groups'

1. Average replenishment time in **months** from Nijmegen to the SSPs: 0.1*
2. Minimum req. fill-rate at the SSPs: decreasing by 0.05 per group from 0.90 to 0.50
3. Minimum req. fill-rate at Nijmegen: for all groups 0.99
4. Number of SSPs: 80*
5. Number of countries: 16*
6. Minimum AMC (Average Monthly Consumption) per country per spare part, for stocking parts in every SSP: 1
7. Minimum AMC per country per spare part, for stocking parts centrally in countries: 0.2
8. Average replenishment time in **months** from vendors to Nijmegen: 0.5*
9. Average lead time in **days** from SSPs to 'customers': 0.5*
10. Average lead time in **days** from (central) country stocking point to 'customers': 1*
11. Average lead time in **days** from Nijmegen to 'customers': 2.5*

These values make up 'scenario 0', which is the starting scenario for the sensitivity analysis. The sensitivity analysis is executed by changing a value of one parameter, while the values of the other parameters are being held constant.
The results of scenario 0 are summarized in table 1.

A sensitivity analysis of six parameters has been executed. During these analyses the influence of the parameters on the *investment in k$* and the *Level Of Service* (and for some parameters the influence on the *lead time to the 'customers'*) has been determined.
The remainder of this appendix deals with the analyses of the six parameters.

Description	Value
Investm. (k$) fast movers in SSPs	6,262.1
Investm. (k$) fast movers in Nijmegen	3,405.3
Tot. investm. (k$) *fast* movers	9,667.4
Av. lead time fast movers to 'customers' (days)	0.515
Tot. investm. (k$) *slow* movers	71,896.9
Av. lead time slow movers to 'customers' (days)	0.97
Total *European* investm. (k$)	81,564.3
Level Of Service (%)	96.92

Table 1 Summarized results of scenario 0

1. Parameter: Replenishment time from Nijmegen to the SSPs (in months)

In the present situation at Digital, the average replenishment time from Nijmegen to the SSPs is approximately equal to 0.1 months (3 days). By changing the value of this parameter within a range of 1 day to 16 days, the effect on the investment in k$ and the Level Of Service can be determined. The value has been changed simultaneously in both worksheets.
For different replenishment times, the investment and the Level Of Service (= the total overall Level Of Service) are depicted in figure 1. (Remember that the other parameters are constants!)

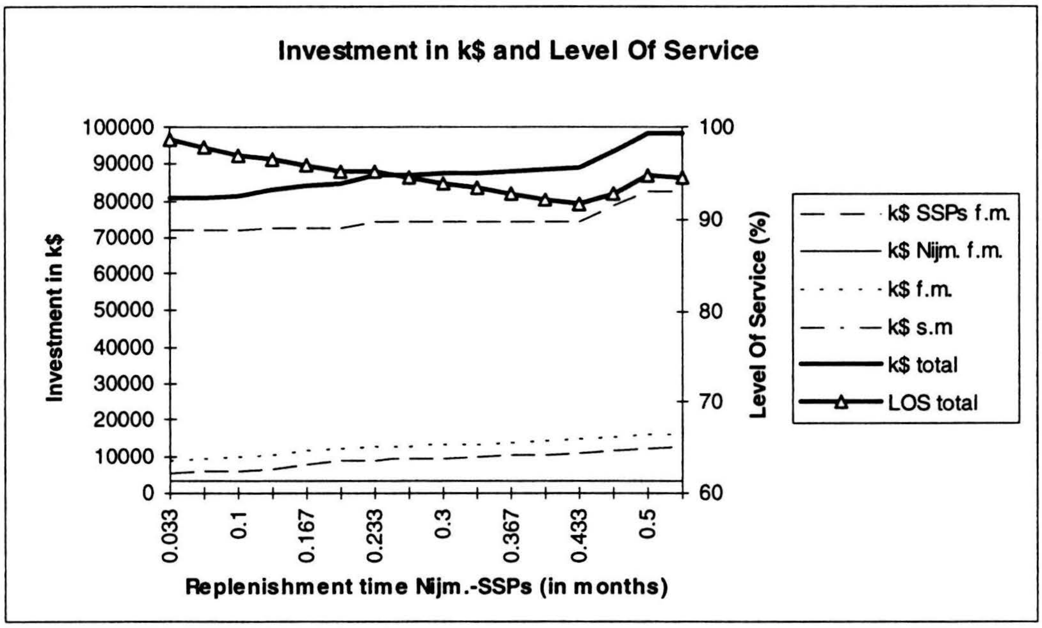


Figure 1 Analysis of the replenishment time from Nijmegen to the SSPs

At a replenishment time of 0.1 months, the values of table 1 can be recognized in figure 1.
At an increasing replenishment time from Nijmegen to the SSPs, the investment in fast movers (f.m.) increases in the SSPs and remains the same in Nijmegen. Of course, the increase of the investment in the SSPs is caused by the direct relationship between the stock levels and the replenishment time. The investment in slow movers (s.m.) increases too, because some groups are also stocked in SSPs. The thick line depicts the increasing total investment in k$, at an increasing replenishment time. The thick marked line shows the Level Of Service at different replenishment times. Although the minimum (required) fill-rates are constants, the Level Of Service decreases. This is caused by the fact that the Level Of Service is based on the calculated fill-rates, that go along with the recommended stock levels. The calculated fill-rates

decrease when the replenishment time from Nijmegen to the SSP increases, because an increasing replenishment time means an increase of the average number of parts due in (DI).
The range of the total investment and the range of the Level Of Service are depicted in table 2.

	Minimum	Maximum
Total European investm. (k$)	80,740.6	98,415.2
Level Of Service (%)	91.64	98.76

Table 2 Range with respect to parameter: Replenishment time Nijmegen to SSPs

2. Parameter: Replenishment time from vendors to Nijmegen (in months)

In the present situation at Digital, the average replenishment time from the vendors to Nijmegen is approximately equal to 0.5 months (15 days). By changing the value of this parameter within a range of 3 days to 30 days, the effect on the total investment and the Level Of Service can be determined. The value has been changed simultaneously in both worksheets.
For different replenishment times, the investment in stock and the Level Of Service (= the total overall Level Of Service) are depicted in figure 2. Again it must be noticed that the other parameters are constants. The value of the parameter 'Replenishment time from Nijmegen to the SSPs' has been put in as 0.1 months again.

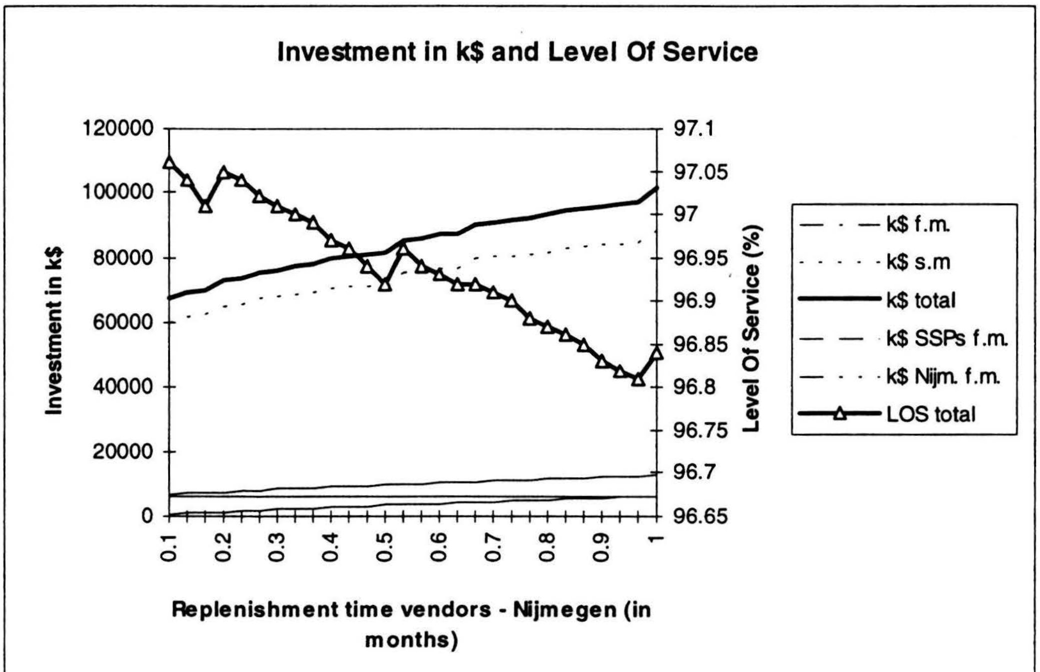


Figure 2 Analysis of the replenishment time from the vendors to Nijmegen

At a replenishment time of 0.5 months, the values of table 1 can be recognized in figure 2.
The investment in fast movers (f.m.) increases as well in the SSPs (although hard to see in the graph) as in Nijmegen. Of course, the investment in Nijmegen (= replenishment stock) increases at a faster rate than the investment in the SSPs, because the replenishment time is directly related to the stock levels in Nijmegen. The slight increase of the investment in the SSPs is caused by the fact that sometimes, when a replenishment order cannot be filled from Nijmegen ('miss-rate'$_{Nijmegen}$), the replenishment time to the SSPs is increased with the replenishment time from the vendors to Nijmegen.

The investment in slow movers (s.m.) also increases, because some groups of parts are stocked in Nijmegen and other are stocked centrally per country or in SSPs. Although not specified in the graph, the increase is mainly caused by the stock, needed for the groups of parts that are stocked in Nijmegen, and the increase of the replenishment stock in Nijmegen for the other groups.

The thick line depicts the increasing total investment in k$, at an increasing replenishment time. The thick marked line shows the Level Of Service at different replenishment times. Although the minimum (required) fill-rates are constants, the Level Of Service slightly decreases. This is caused by the fact that the Level Of Service is based on the calculated fill-rates, that go along with the recommended stock levels. The calculated fill-rates decrease when the replenishment time from Nijmegen to the SSP increases, because an increase of this replenishment time means an increase of the average number of parts due in (DI). The way the replenishment time to the SSPs is influenced by the replenishment time from the vendors to Nijmegen has just been explained above (see 'miss-rate'$_{Nijmegen}$).
The range of the total investment and the range of the Level Of Service are depicted in table 3. As can be seen in the table, the range of the Level Of Service is indeed very small (0.22%).

	Minimum	Maximum
Total European investm. (k$)	67,126.9	101,310.5
Level Of Service (%)	96.84	97.06

Table 3 Range with respect to parameter: Replenishment time vendors to Nijmegen

3. Parameter: Minimum AMC per country per spare part, for stocking parts in every SSP

Next to the effect on the investment in stock and the Level Of Service, also the influence on the average lead time to the 'customer' has been investigated with respect to this parameter. The value of this parameter in scenario 0 has been chosen arbitrarily. As this parameter only occurs in the worksheet 'Groups', the investment in stock, the contribution to the overall Level Of Service and the average lead time to the 'customers' with respect to the fast movers remains the same.

For different values of the AMC, the investment in stock and the Level Of Service (= the total overall Level Of Service) are depicted in figure 3. The average lead time to the 'customers' is depicted in figure 4.

At a minimum AMC of 1 per country, the values of table 1 can be recognized in figure 3 and figure 4.
As mentioned before, figure 3 shows that the investment in stock for fast movers remains constant, while figure 4 shows that the average lead time of fast movers to the 'customers' remains 0.515 days. Furthermore, figure 3 shows that, at an increasing value of the minimum AMC, the total investments in stock decreases. This is quite obvious, because increasing the minimum AMC for stocking in every SSP means, that more and more parts (or groups) will not be qualified for stocking in every SSP. Hence, more and more parts will be stocked centrally per country. The effect of central stocking instead of stocking in every SSP, is a decrease of the total stock level and hence, a decrease of the total investment in stock.

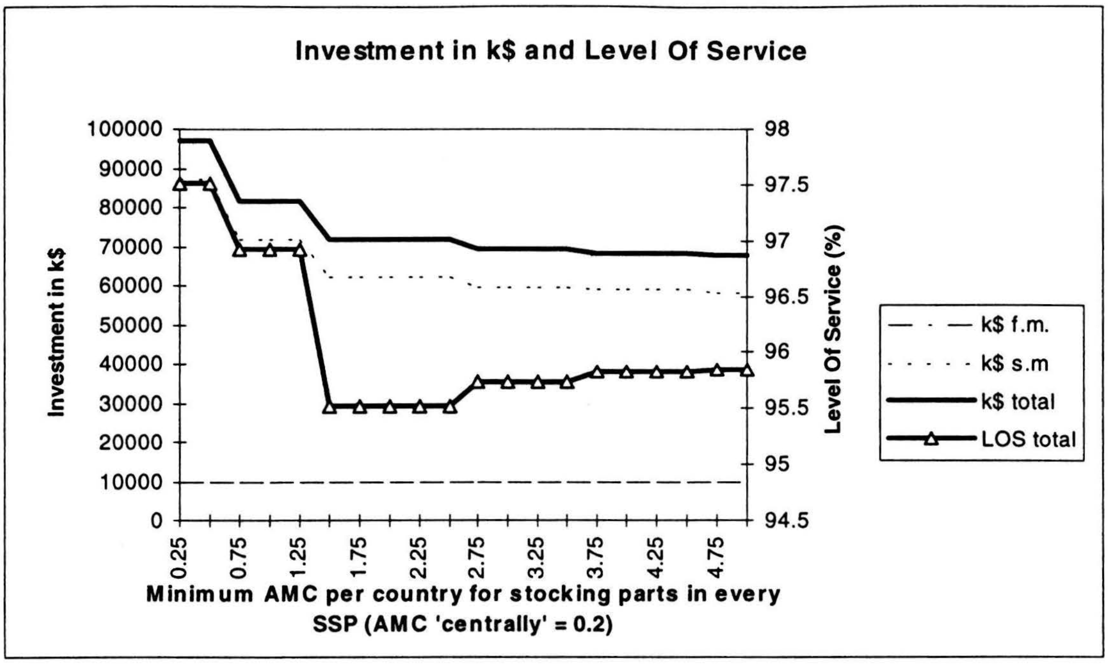


Figure 3 Analysis of the minimum AMC per country per spare part, for stocking parts in every SSP

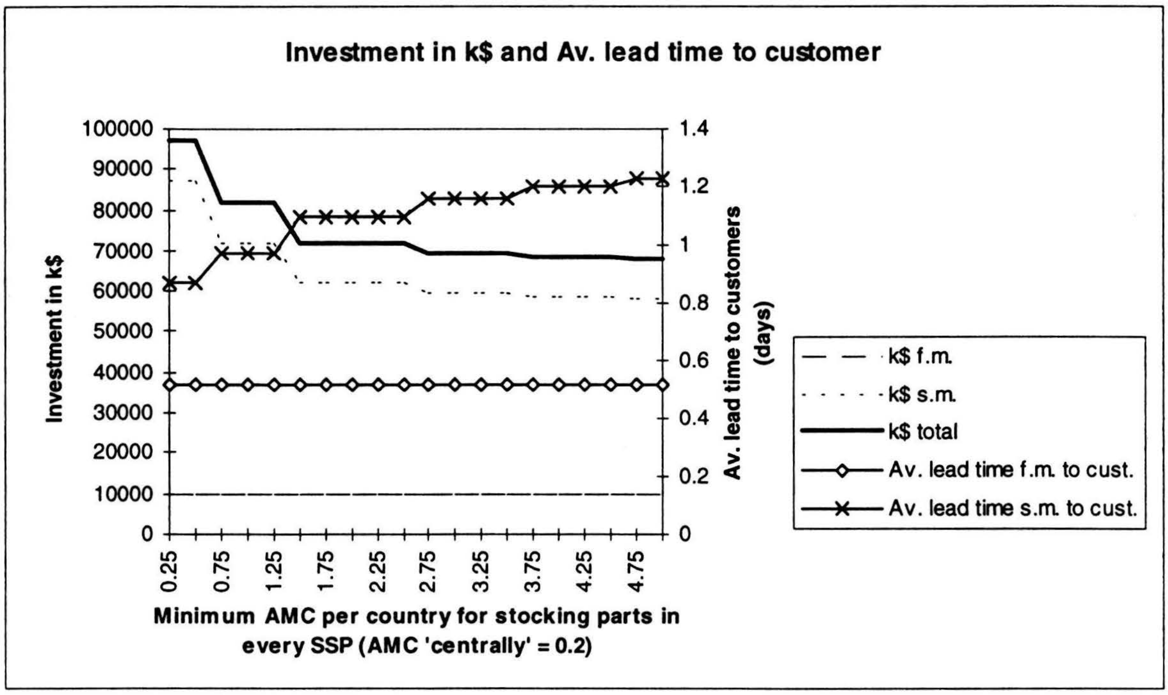


Figure 4 Analysis of the minimum AMC per country per spare part, for stocking parts in every SSP

Figure 3 also shows a decreasing Level Of Service at an increasing value of the minimum AMC.

This effect can only be explained by the fact that, at a particular recommended stock level, the calculated fill-rate at a central (country) stocking room differs from the calculated fill-rate at an SSP. The former is based on the average monthly consumption per country and the latter is based on the average monthly consumption per SSP. As the consumption per country is higher than the consumption per SSP, the calculated fill-rate at a central stocking room will be lower.

Because an increasing value of the minimum AMC means that more and more parts are stocked centrally in the countries, the Level Of Service, which is based on the calculated fill-rates, will decrease.
However, this effect does not always occur (see the next parameter). It only occurs when the recommended stock level remains the same!

Finally, figure 4 shows that the average lead time of slow movers (s.m.) to the 'customers' increases, at an increasing minimum AMC. This is quite obvious, because more and more parts are going to be stocked centrally in the countries, instead of in every SSP.

The ranges of the total investment, the Level Of Service and the lead time to the 'customers' (for fast- and slow movers) are depicted in table 4.
As can be seen in the table, the range of the Level Of Service is small (1.99%).

	Minimum	**Maximum**
Total European investm. (k$)	67,813.5	96,980.0
Level Of Service (%)	95.53	97.52
Av. lead time to cust. (f.m.) (days)	0.515	0.515
Av. lead time to cust. (s.m.) (days)	0.87	1.23

Table 4 Range with respect to parameter: Minimum AMC per country per spare part, for stocking parts in every SSP

4. Parameter: Minimum AMC per country per spare part, for stocking parts centrally in countries

Next to the effect on the investment in stock and the Level Of Service, also the influence on the average lead time to the 'customer' has been investigated with respect to this parameter. The value of this parameter in scenario 0 has been chosen arbitrarily. As this parameter only occurs in the worksheet 'Groups', the investment in stock, the contribution to the overall Level Of Service and the average lead time to the 'customers' with respect to the fast movers remains the same.

For different values of this minimum AMC, the investment in stock and the Level Of Service (= the total overall Level Of Service) are depicted in figure 5. The average lead time to the 'customers' is depicted in figure 6.

At a minimum AMC of 0.2 per spare part per country, the values of table 1 can be recognized in figure 5 and figure 6.
As mentioned before, figure 5 shows that the investment in stock for fast movers remains constant, while figure 6 shows that the average lead time of fast movers to the 'customers' remains 0.515 days. Furthermore, figure 5 shows that, at an increasing value of the minimum AMC, the total investments in stock decreases. This is obvious, because increasing the minimum AMC for stocking centrally in countries means, that more and more parts (or groups) will not be qualified for stocking centrally in the countries. Hence, more and more parts will be stocked in Nijmegen. The consequence of stocking in Nijmegen instead of stocking in every country, is a decrease of the total stock level and hence, a decrease of the total investment in stock.

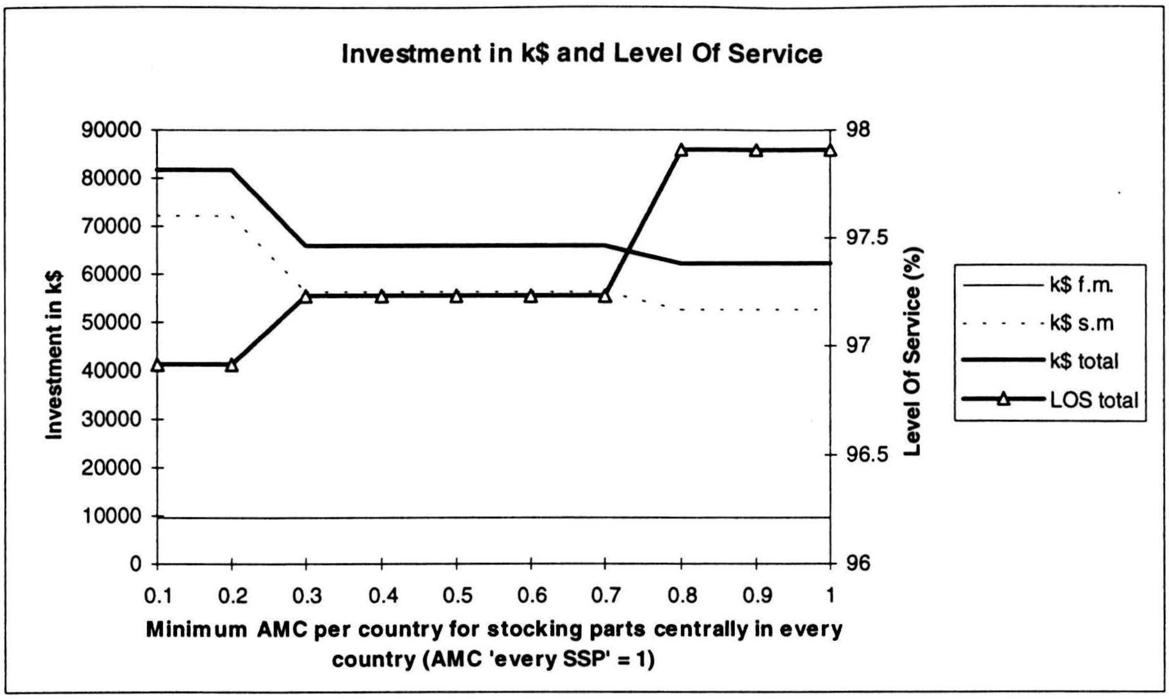


Figure 5 Analysis of the minimum AMC per country per spare part, for stocking parts centrally in countries

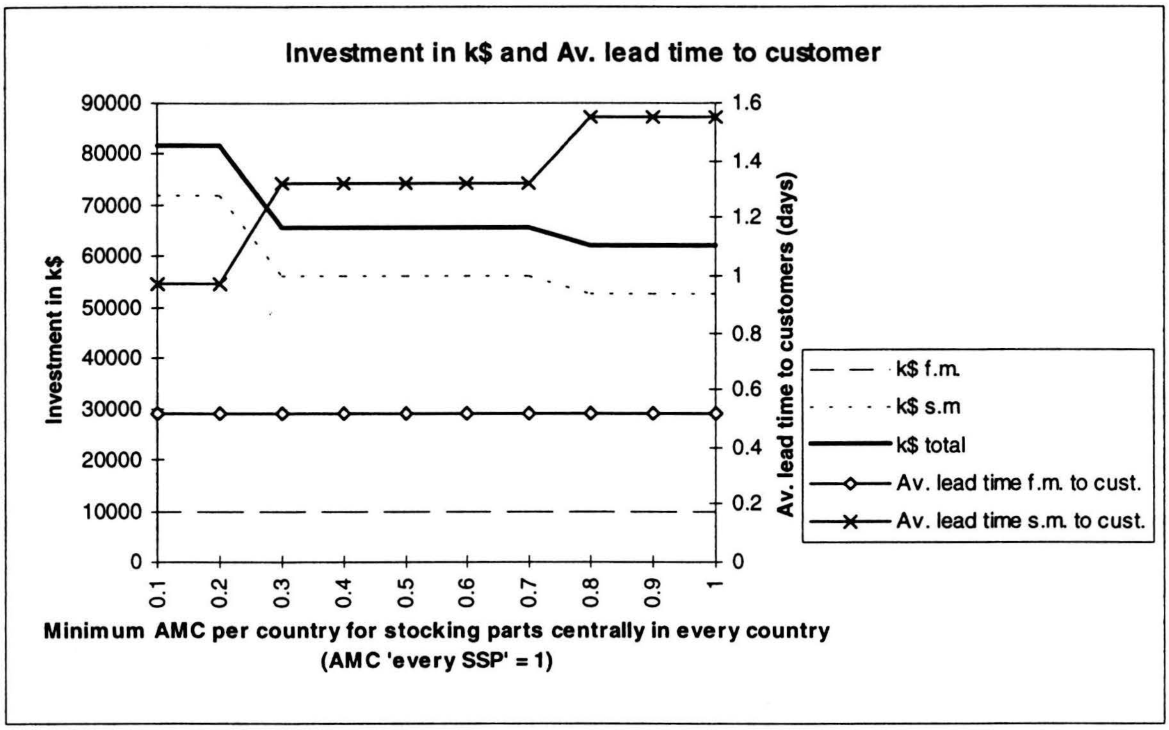


Figure 6 Analysis of the minimum AMC per country per spare part, for stocking parts centrally in countries

Figure 5 also shows an increasing Level Of Service at an increasing value of the minimum AMC.

This is the same effect as mentioned with respect to the previous parameter, only now the recommended stock levels do not remain the same! To fulfill the minimum required fill-rate at Nijmegen, the worksheet recommends a higher stock level (in Nijmegen). In this case, the net effect of these higher stock levels is an increase of the total LOS.

Finally, figure 6 shows that the average lead time of slow movers (s.m.) to the 'customers' increases, at an increasing minimum AMC. This is obvious, because more and more parts are going to be stocked in Nijmegen, instead of centrally in the countries.

The ranges of the total investment, the Level Of Service and the lead time to the 'customers' (for fast- and slow movers) are depicted in table 5.
As can be seen in the table, the range of the Level Of Service is small (0.99%).

	Minimum	Maximum
Total European investm. (k$)	62,169.7	81,564.3
Level Of Service (%)	96.92	97.91
Av. lead time to cust. (f.m.) (days)	0.515	0.515
Av. lead time to cust. (s.m.) (days)	0.97	1.55

Table 5 Range with respect to parameter: Minimum AMC per country per spare part, for stocking parts centrally in the countries

5. Parameter: Minimum fill-rate at Nijmegen

The value of this parameter in scenario 0 has been chosen to approximate a 'desirable' future situation. As this parameter occurs in both worksheets, the value of this parameter has been changed simultaneously in both worksheets. The worksheet 'Groups' offers the possibility to distinct between groups with respect to the fill-rate. Though, for the sake of simplicity, all minimum required fill-rates with respect to the different groups are supposed to be the same during this sensitivity analysis.
By changing the value of this parameter, the effect on the investment in stock and the Level Of Service has been investigated. To approximate a very high fill-rate, fill-rates of 0.999 and 0.9999 have been inserted into the worksheets. Of course, a fill-rate equal to 1 is not possible.
Figure 7 depicts the investment in stock and the Level Of Service for different values of the minimum required fill-rate at Nijmegen.

At a minimum required fill-rate of 0.99, the values of table 1 can be recognized in figure 7.
The graph shows that at decreasing fill-rates at Nijmegen, the investment in fast movers (f.m.) in Nijmegen decreases, while the investment in fast movers in the SSPs increases. This last effect is caused by the fact that the required fill-rate at the SSPs remains constant (during this analysis). A decreasing fill-rate at Nijmegen means an increase of the average replenishment time to the SSPs (see explanation given before) and hence an increase of the required stock levels in the SSPs.
The total investment in fast movers reaches a minimum between a fill-rate at Nijmegen of 0.98 and 0.99.
The investment in slow movers (s.m.) is not specified with respect to Nijmegen and the SSPs. On the average, the total investment in slow movers is increasing at an increasing minimum required fill-rate at Nijmegen. It is expected that this effect requires no further explanation.
The increase of the investment in slow movers is bigger than the initial decrease of the investment in fast movers. Therefore, the total investment in stock does not reach a minimum <u>between</u> fill-rates of 0.5 and 0.99.
It is nice to see that, at very high minimum required fill-rates, the total investment in stock (thick line) is increasing considerably. On the contrary, the total Level Of Service (thick marked line) almost remains the same at very high required fill-rates. Therefore, it can be concluded that striving for very high fill-rates, basically costs a lot of money, but does not have much impact on the final Level Of Service.

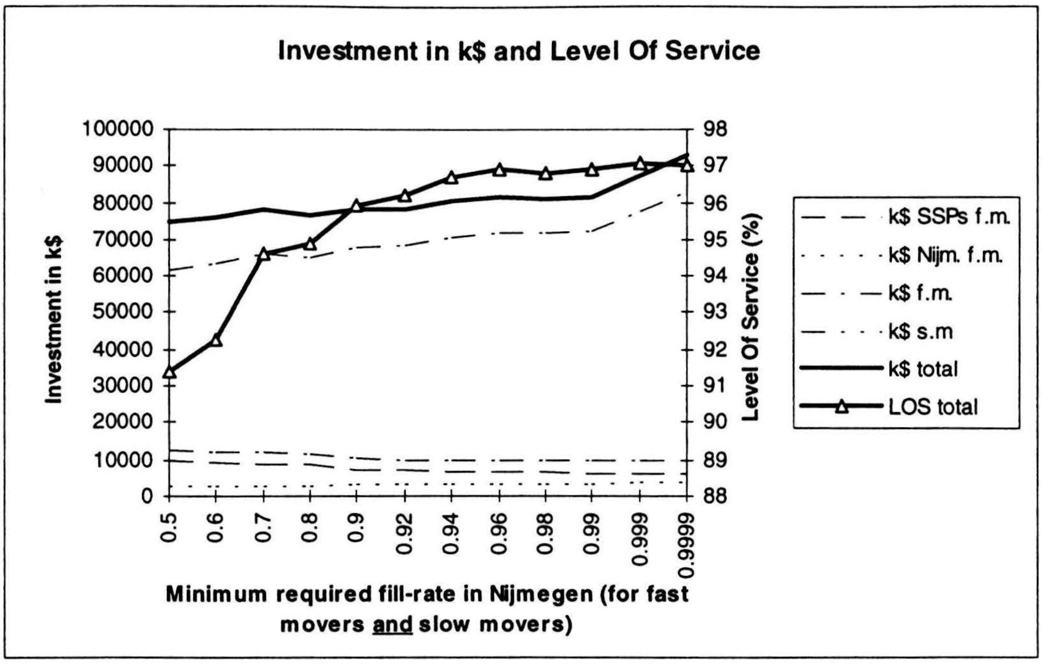


Figure 7 Analysis of the minimum required fill-rate at Nijmegen

The range of the total investment and the range of the Level Of Service are depicted in table 6. As can be seen in the table, the range of the Level Of Service is considerably bigger (5.7%) than the former ones (except for the range resulting from the parameter 'replenishment time Nijmegen to the SSPs')

This is obvious, because the fill-rate, more or less, is the parameter to directly influence the Level Of Service.

	Minimum	Maximum
Total European investm. (k$)	74,596.9	92,833.4
Level Of Service (%)	91.38	97.08

Table 6 Range with respect to parameter: Minimum required fill-rate at Nijmegen

Of course, especially the contribution to the overall Level Of Service of the groups, that are only stocked in Nijmegen, is influenced. Though, also the contribution to the overall Level Of Service of fast movers is influenced. For, the calculated fill-rates at particular stock levels in the SSPs change at a changing fill-rate at Nijmegen.

6. Parameter: Minimum fill-rate at the SSPs

For the sensitivity analysis of this parameter scenario 0 has not been used as starting scenario. For, it was easier to work with only one changing fill-rate in both worksheets. (In scenario 0 the fill-rates in worksheet 'Groups' were all different.) Due to this, values of table 1 are not recognizable in figure 8. The values of the other parameters did remain equal to the values of scenario 0.

The value of the minimum required fill-rate at the SSPs has been changed simultaneously in both worksheets.

By changing the value of this parameter, the effect on the investment in stock and the Level Of Service has been investigated. To approximate a very high fill-rate, fill-rates of 0.999 and 0.9999 have been inserted into the worksheets. Of course, a fill-rate equal to 1 is not possible.

Figure 8 depicts the investment in stock and the Level Of Service for different values of the minimum required fill-rate at the SSPs.

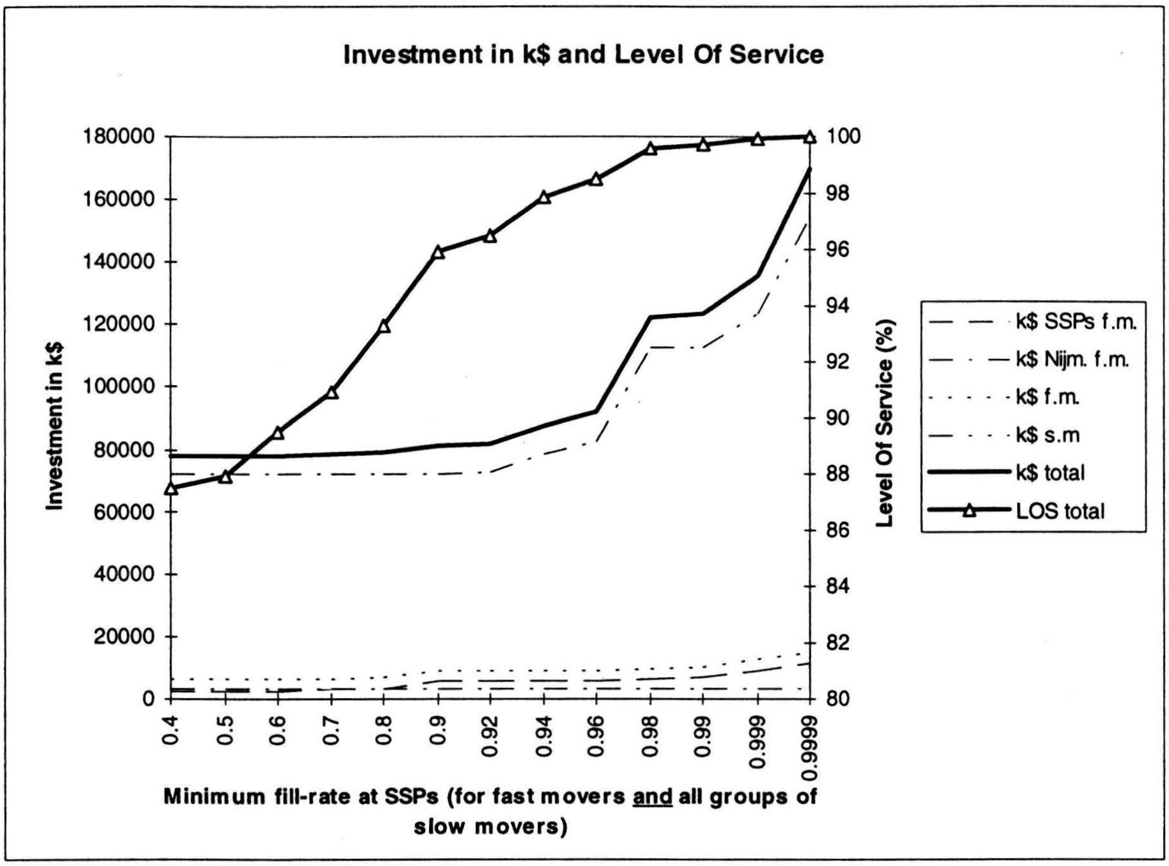


Figure 8 Analysis of the minimum required fill-rate at the SSPs

At an increasing required fill-rate the investment in fast movers (f.m.) in the SSPs increases. This is obvious, because in order to be able to meet demand directly from the shelf more often, more stock is needed. In this way, it is also clear that the stock levels of fast movers in Nijmegen (replenishment stock) are not influenced by an increasing fill-rate at the SSPs.

Overall, the investment in slow movers (s.m.) also increases, although it remains constant initially. The investment in slow movers remains constant at lower fill-rates, because the difference between the calculated fill-rates at the recommended stock level and the required fill-rates is big enough to keep the recommended stock at the same level. From a required fill-rate of 0.92, the investment in slow movers starts to increase. Although not specified, the increase is caused by the groups that are stocked in the SSPs or in a central stocking room in the countries, since stock levels of parts that are stocked in Nijmegen are not influenced.

Bottom line, the total investment in stock (thick line) increases at an increasing required fill-rate at the SSPs.

Furthermore, figure 8 shows that the total Level Of Service is also increasing at an increasing fill-rate at the SSPs.

Next, it is shown again, that the investment in stock increases very rapidly, if the minimum required fill-rate approaches 1. On the other hand, the improvement of the total Level Of Service is marginal at higher fill-rates.

The range of the total investment and the range of the Level Of Service are depicted in table 7. As can be seen in the table, the range of the Level Of Service is very large (12.45%).

This is obvious, because the fill-rate is the parameter to directly influence the Level Of Service.

	Minimum	Maximum
Total European investm. (k$)	78,021.4	169,528.0
Level Of Service (%)	87.52	99.97

Table 7 Range with respect to parameter: Minimum required fill-rate at the SSPs

Especially this fill-rate has much influence on the total Level Of Service, because the bigger part of the spare parts are stocked in the SSPs or in a central stocking room in the countries. Only three groups of spare parts, with a total ptc of 5.84% are stocked in Nijmegen. (Remember that stock levels in Nijmegen are not influenced by a changing required fill-rate at the SSPs.)

Conclusions

The sensitivity analyses of the six parameters learns that there are three parameters, which have a large influence on the Level Of Service (see table 2 to 6). These parameters are:

- the replenishment time from Nijmegen to the SSPs (in months);
- the minimum required fill-rate at Nijmegen;
- the minimum required fill-rate at the SSPs.

As Digital wants to determine how much stock has to be maintained in order to fulfill a pre-specified Level Of Service, it is recommended to use these parameters as major control parameters in the worksheets.
After Digital has determined the required Level Of Service, first the most likely minimum value of the parameter 'replenishment time from Nijmegen to the SSPs' should be inserted into the worksheets. It should be the most likely minimum value, for this means that less stock is needed.
After that, the value of the required minimum fill-rate at Nijmegen should be inserted. It is recommended to strive for a considerable high fill-rate at Nijmegen, because the required increase of the investments in stock is less, than the required increase of investments in stock for high fill-rates at the SSPs. Though, figure 7 learns that fill-rates at Nijmegen, higher than 0.99, require a disproportionate extra investment in stock.
Finally, the value of the minimum required fill-rate at the SSPs must be inserted. Then, the total Level Of Service will show, whether or not the fill-rates at the SSPs are high enough.
If the total (calculated) LOS is high enough, the spreadsheet shows the recommended stock levels and the amount of money that is involved.

Next, Digital has to check whether or not the average lead times to the 'customers' are acceptable. If not, the values of the parameters 'minimum AMC per ... in every SSP' and 'minimum AMC per ... in countries' must be adapted. Decreasing the values of these parameters results in shorter average lead times. Increasing the values of these parameters results in longer average lead times.
As these parameters have a slight effect on the Level Of Service, the calculated Level Of Service should be compared again to the required Level Of Service.

As the worksheet 'Groups' offers the possibility to distinct between fill-rates of different groups, some 'fine-tuning' could be done in order to decrease the total investment in stock. However, the total Level Of Service should be checked again.

The parameter 'replenishment time from the vendors to Nijmegen' should just be as low as possible (but also realistic), in order to limit the investments in stock!

Appendix 18

Scenario 50-0-50; worksheet 'fast movers per SSP'

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC
1	Fast movers				Replenishment time	Stocklevel	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Recommended	Tot. number of	Investm. in k$	LOS	Replenishment	Investm. in k$	Weighted av. lead time noticed
2	Partnumber	Price($)	Av. dem.	pAc(%)	0.1	Due in (0-)		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	stock level	parts in SSPs	in SSPs		stock Nijm. (#)	in Nijmegen	by a customer (see k4al)
3	-LK401-AA	35.0	11.27	1.03			0.000	0.306	0.669	0.883	0.968	0.993	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	4	320	11.2	0.998	501	17.5	0.016
4	-RX23L-AA	17.1	10.15	0.93	The table depicts the fill-rate with		0.000	0.344	0.712	0.907	0.977	0.995	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	4	320	5.5	0.907	453	7.7	0.014
5	29-28288-02	123.3	9.45	0.86	respect to a particular spare		0.000	0.371	0.738	0.921	0.981	0.996	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	4	320	39.5	0.849	424	52.3	0.012
6	30-43478-02	93.5	8.83	0.81	part, in case of different stock		0.000	0.396	0.763	0.933	0.985	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	4	320	29.9	0.795	397	37.1	0.011
7	54-24486-01	243.6	7.25	0.66	levels		0.000	0.467	0.822	0.958	0.992	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	58.5	0.636	330	80.4	0.010
8	-LK401-AT	26.0	6.97	0.64			0.000	0.481	0.833	0.962	0.993	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	6.2	0.613	318	8.3	0.010
9	-THXXD-01	69.0	6.14	0.56	Min. fill-rate SSPs	0.95	0.000	0.525	0.863	0.972	0.996	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	16.6	0.546	283	19.5	0.008
10	PCXAS-AD	6.4	6.06	0.55			0.000	0.529	0.866	0.973	0.996	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	1.5	0.540	279	1.8	0.008
11	70-26536-02	128.2	6.06	0.55	Number of SSPs	80	0.000	0.529	0.866	0.973	0.996	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	30.8	0.539	279	35.8	0.008
12	-VSXXX-GA	13.9	5.91	0.54			0.000	0.537	0.871	0.975	0.996	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	3.3	0.527	273	3.8	0.008
13	30-42709-01	22.5	5.65	0.52	Replenishment time vendors		0.000	0.552	0.880	0.978	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	5.4	0.506	262	5.9	0.008
14	FD-W001F-01	5.8	5.65	0.52	to Nijm. (months)	0.50	0.000	0.552	0.880	0.978	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	1.4	0.505	262	1.5	0.008
15	70-24577-02	108.2	5.54	0.51			0.000	0.559	0.884	0.979	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	26.0	0.496	257	27.8	0.007
16	-PC7XS-AA	5.4	5.54	0.51	Min. fill-rate Nijm	0.99	0.000	0.559	0.884	0.979	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	1.3	0.496	257	1.4	0.007
17	-LK401-AP	30.0	4.89	0.45			0.000	0.598	0.906	0.985	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	7.2	0.441	229	6.9	0.006
18	-PCXBV-PE	213.6	4.72	0.43	Av. lead time SSP		0.000	0.609	0.911	0.986	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	51.3	0.426	221	47.2	0.006
19	54-24068-01	235.6	4.68	0.43	to 'customer' (days)	0.5	0.000	0.612	0.912	0.986	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	56.5	0.422	220	51.8	0.006
20	-RZ284-VA	499.1	4.47	0.41			0.000	0.625	0.919	0.988	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	119.8	0.404	211	106.3	0.006
21	-DE206-AC	39.8	4.16	0.38	Av. lead time Nijmegen		0.000	0.646	0.928	0.990	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	9.5	0.377	197	7.8	0.006
22	-PCXCV-SA	199.5	4.10	0.38	to 'customer' (days)	2.5	0.000	0.650	0.930	0.990	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	47.9	0.372	194	38.7	0.006
23	-RZ29B-VA	786.5	4.03	0.37			0.000	0.655	0.932	0.991	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	188.8	0.365	191	150.2	0.006
24	-RZ28-VA	488.2	3.93	0.36			0.000	0.662	0.935	0.991	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	117.2	0.357	187	91.3	0.006
25	-PCXBV-TD	298.0	3.67	0.34	Totals:		0.000	0.680	0.942	0.993	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	71.5	0.333	175	52.2	0.006
26	29-28415-01	8.0	3.66	0.33	Parts in SSPs	30160	0.000	0.681	0.943	0.993	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	1.9	0.332	175	1.4	0.006
27	-RE45B-E	136.0	3.60	0.33	Parts in Nijmegen	20257	0.000	0.685	0.944	0.993	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	32.6	0.327	172	23.4	0.006
28	-PCXBV-SA	234.0	3.59	0.33		50417	0.000	0.686	0.945	0.993	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	56.2	0.326	172	40.2	0.004
29	29-25102	9.0	3.54	0.32			0.000	0.690	0.946	0.994	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	2.2	0.322	170	1.5	0.004
30	70-32162-01	38.7	3.29	0.30	k$ in SSPs	5743.0	0.000	0.708	0.952	0.995	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	8.2	0.287	159	6.2	0.006
31	29-25104	13.7	3.28	0.30	k$ in Nijmegen	3405.3	0.000	0.708	0.953	0.995	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.2	0.286	158	2.2	0.006
32	-RZ26L-E	306.0	3.25	0.30		9148.2	0.000	0.711	0.953	0.995	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	48.8	0.284	157	47.9	0.006
33	29-28287-01	12.4	3.20	0.29			0.000	0.714	0.955	0.995	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.0	0.280	155	1.9	0.006
34	-PCXRA-AF	141.0	3.11	0.28	Contribution to LOS	36.8	0.000	0.721	0.957	0.995	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	22.6	0.272	151	21.3	0.004
35	30-39608-03	331.0	3.06	0.28			0.000	0.726	0.958	0.996	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	53.0	0.268	148	49.0	0.004
36	-LK401-AG	28.0	3.01	0.28	Av. lead time in days noticed		0.000	0.729	0.959	0.996	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	4.2	0.264	147	3.8	0.004
37	29-29971-01	99.4	2.98	0.27	by customers	0.541	0.000	0.732	0.960	0.996	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	15.9	0.262	145	14.4	0.004
38	54-23170-AA	81.6	2.93	0.27			0.000	0.735	0.961	0.996	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	13.1	0.257	143	11.7	0.004
39	-PCXRA-AI	138.0	2.84	0.26			0.000	0.742	0.963	0.996	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	22.1	0.250	139	19.2	0.004
40	-PCXLA-GS	12.2	2.83	0.26			0.000	0.743	0.964	0.996	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.9	0.250	139	1.7	0.004
41	30-44823-02	300.0	2.83	0.26			0.000	0.743	0.964	0.996	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	48.0	0.249	138	41.4	0.004
42	-DECXM-AA	35.6	2.83	0.26			0.000	0.743	0.964	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	5.7	0.249	138	4.9	0.004
43	29-32545-01	25.9	2.82	0.26			0.000	0.744	0.964	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	4.1	0.248	138	3.6	0.004
44	-BC13L-10	14.0	2.76	0.25			0.000	0.749	0.965	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.2	0.244	135	1.9	0.004
45	29-28281-01	12.2	2.73	0.25			0.000	0.751	0.966	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.0	0.242	134	1.6	0.004
46	-DE450-CA	33.6	2.67	0.24			0.000	0.756	0.967	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	5.4	0.236	131	4.4	0.004
47	-TZ30-AX	400.0	2.66	0.24			0.000	0.757	0.968	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	64.0	0.235	131	52.4	0.004
48	12-23599-08	9.1	2.64	0.24			0.000	0.758	0.968	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.5	0.234	130	1.2	0.004
49	-LK411-AA	30.5	2.59	0.24			0.000	0.762	0.969	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	4.9	0.230	128	3.9	0.004
50	-TK85K-01	28.0	2.56	0.23			0.000	0.764	0.970	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	4.5	0.227	126	3.5	0.003
51	PCXLA-GE	12.2	2.55	0.23			0.000	0.765	0.970	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.9	0.226	126	1.5	0.003
52	-H4006-	40.3	2.45	0.22			0.000	0.773	0.972	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	6.4	0.218	122	4.9	0.003
53	29-29972-01	146.4	2.44	0.22			0.000	0.774	0.972	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	23.4	0.217	121	17.7	0.003
54	FD-44365-01	11.4	2.43	0.22			0.000	0.775	0.973	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.8	0.216	121	1.4	0.003
55	54-23580-02	104.0	2.43	0.22			0.000	0.775	0.973	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	16.6	0.216	121	12.6	0.003
56	-VRC21-HA	1086.1	2.42	0.22			0.000	0.776	0.973	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	173.8	0.215	120	130.3	0.003
57	54-22703-07	96.9	2.38	0.22			0.000	0.779	0.974	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	15.5	0.212	118	11.4	0.003
58	54-24544-02	136.8	2.35	0.22			0.000	0.781	0.974	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	21.9	0.210	117	16.0	0.003
59	-ME524-DE	28.8	2.29	0.21			0.000	0.786	0.975	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	4.6	0.204	114	3.3	0.003
60	-PCXBV-SC	293.0	2.29	0.21			0.000	0.786	0.975	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	46.9	0.204	114	33.4	0.003
61	FR-PCP7H-AD	18.0	2.28	0.21			0.000	0.787	0.976	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.9	0.203	114	2.1	0.003
62	29-28277-01	8.9	2.27	0.21			0.000	0.788	0.976	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.4	0.203	113	1.0	0.003
63	-TLZ07-BA	535.0	2.25	0.21			0.000	0.790	0.976	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	85.6	0.201	112	59.9	0.003
64	-PCXAL-GE	16.5	2.18	0.20			0.000	0.795	0.977	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.6	0.195	109	1.8	0.003
65	30-41996-01	249.0	2.18	0.20			0.000	0.796	0.978	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	39.8	0.195	109	27.1	0.003
66	29-25918	86.8	2.17	0.20			0.000	0.796	0.978	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	13.9	0.194	109	9.5	0.003
67	-DSRVB-AB	145.0	2.15	0.20			0.000	0.798	0.978	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	23.2	0.193	108	15.7	0.003
68	FD-74510-DL	51.0	2.10	0.19			0.000	0.802	0.979	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	8.2	0.188	106	5.4	0.003
69	-LA75S-A3	214.5	2.10	0.19			0.000	0.802	0.979	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	34.3	0.188	106	22.7	0.003
70	-LN11X-AA	72.7	2.09	0.19			0.000	0.803	0.979	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	11.6	0.188	106	7.7	0.003
71	54-23544-04	162.5	2.09	0.19			0.000	0.803	0.979	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	26.0	0.187	105	17.1	0.003
72	-TK50-AX	173.9	2.08	0.19			0.000	0.804	0.979	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	27.8	0.186	105	18.3	0.003
73	FR-PCP8H-AD	31.0	2.08	0.19			0.000	0.804	0.979	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	5.0	0.186	105	3.3	0.003
74	29-29328-01	211.1	2.04	0.19			0.000	0.807	0.980	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	33.8	0.183	103	21.7	0.003
75	-PCXCV-AC	225.0	2.04	0.19			0.000	0.808	0.980	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	36.0	0.183	103	23.2	0.003
76	29-27880-01	110.8	2.01	0.18			0.000	0.810	0.981	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	17.7	0.180	102	11.3	0.003
77	-PCXBV-DE	86.4	2.01	0.18			0.000	0.810	0.981	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	13.8	0.180	102	8.8	0.003
78	70-20689-01	70.0	1.99	0.18			0.000	0.811	0.981	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	11.2	0.179	101	7.1	0.003
79	-RZ26B-VW	810.4	1.88	0.17			0.000	0.821	0.983	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	129.7	0.169	96	77.8	0.002
	-RE24M-E	132.1	1.87	0.17			0.000	0.822	0.983	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	21.1	0.168	95	12.6	0.002
	30-41069-01	75.3	1.87	0.17			0.000	0.822	0.983	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	12.1	0.168	95	7.2	0.002
	FE-MID11-OR	79.4	1.79	0.16			0.000	0.828	0.984	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	12.7	0.162	92	7.3	0.002
83	29-25916	56.6	1.78	0.16			0.000	0.830	0.985	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	9.0	0.160	91	5.1	0.002
84	70-26534-04	49.1	1.75	0.16			0.000	0.832	0.986	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	7.9	0.158	90	4.4	0.002
85	-TLZ04-DA	750.0	1.75	0.16			0.000	0.833	0.985	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	120.0	0.157	90	87.5	0.002
86	30-41318-02	25.9	1.74	0.16			0.000	0.833	0.985	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	4.1	0.157	90	2.3	0.002
87	-LK401-AS	26.0	1.72	0.16			0.000	0.835	0.985	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	4.2	0.155	89	2.3	0.002
88	70-19655-01	50.0	1.72	0.16			0.000	0.835	0.986	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	8.0	0.155	89	4.5	0.002
89	-RZ26L-VA	300.0	1.72	0.16			0.000	0.835	0.986	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	48.0	0.155	88	26.4	0.002
90	-PCXBV-TZ	286.0	1.69	0.15			0.000	0.837	0.986	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	45.8	0.152	87	24.9	0.002
91	-RD53-A	281.0	1.68	0.15			0.000	0.838	0.986	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	45.0	0.152	87	24.5	0.002

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC
1	Fast movers				Replenishment time	Stocklevel	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Recommended	Tot number of	Investm in k$	LOS	Replenishment	Investm in k$	Weighted av lead time noticed
2	Partnumber	Price($)	Av dem	plc(%)	0,1	Due in (0-)		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	stock level	parts in SSPs	in SSPs		stock Nijm (#)	in Nijmegen	by a customer (see total)
92	70-28824-01	6.9	1.66	0.15			0.000	0.840	0.987	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.1	0.149	86	0.6	0.002
93	-RX10 -AA	31.4	1.65	0.15			0.000	0.841	0.987	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	5.0	0.149	85	2.7	0.002
94	-LK411-AG	18.0	1.64	0.15			0.000	0.842	0.987	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.9	0.148	85	1.5	0.002
95	FE-PAE06-OX	15.0	1.63	0.15			0.000	0.843	0.987	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.4	0.147	84	1.3	0.002
96	54-22249-01	694.1	1.63	0.15			0.000	0.843	0.987	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	111.0	0.147	84	58.3	0.002
97	-H8675-A	6.1	1.60	0.15			0.000	0.846	0.987	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.0	0.144	83	0.5	0.002
98	30-43517-01	724.5	1.59	0.15			0.000	0.846	0.987	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	115.9	0.144	83	60.1	0.002
99	FE-PAE10-OS	151.0	1.59	0.15			0.000	0.846	0.988	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	24.2	0.144	83	12.5	0.002
100	FD-09842-DL	300.0	1.58	0.14			0.000	0.847	0.988	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	48.0	0.143	82	24.6	0.002
101	12-41768-03	16.8	1.56	0.14			0.000	0.849	0.988	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.7	0.141	81	1.4	0.002
102	FD-W0JJW-01	155.0	1.54	0.14			0.000	0.851	0.988	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	24.8	0.139	80	12.4	0.002
103	-PC7XV-DE	231.0	1.54	0.14			0.000	0.851	0.988	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	37.0	0.139	80	18.5	0.002
104	-TLZ06-BA	550.0	1.54	0.14			0.000	0.851	0.988	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	88.0	0.139	80	44.0	0.002
105	29-30358-01	143.5	1.53	0.14			0.000	0.851	0.988	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	23.0	0.139	80	11.5	0.002
106	54-21246-BA	55.6	1.53	0.14			0.000	0.852	0.988	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	8.9	0.138	80	4.5	0.002
107	-RE23R-E	102.5	1.52	0.14			0.000	0.853	0.989	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	16.4	0.137	79	8.1	0.002
108	30-40960-01	1100.0	1.51	0.14			0.000	0.854	0.989	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	176.0	0.136	79	86.9	0.002
109	FD-W07WP-01	35.6	1.50	0.14			0.000	0.854	0.989	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	5.7	0.136	79	2.8	0.002
110	FD-W06P7-01	36.3	1.48	0.14			0.000	0.856	0.989	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	5.8	0.134	78	2.8	0.002
111	-TLZ06-DX	700.0	1.46	0.13			0.000	0.858	0.989	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	112.0	0.132	77	53.9	0.002
112	-VRC21-W3	971.0	1.44	0.13			0.000	0.860	0.990	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	155.4	0.130	76	73.8	0.002
113	29-28089-	139.7	1.44	0.13			0.000	0.860	0.990	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	22.3	0.130	76	10.6	0.002
114	29-28293-01	16.8	1.43	0.13			0.000	0.860	0.990	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.7	0.130	75	1.3	0.002
115	FD-82195-DL	345.0	1.42	0.13			0.000	0.861	0.990	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	55.2	0.129	75	25.9	0.002
116	12-13097-	10.0	1.41	0.13			0.000	0.862	0.990	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.6	0.128	74	0.7	0.002
117	29-28272-01	7.1	1.40	0.13			0.000	0.863	0.990	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.1	0.127	74	0.5	0.002
118	FD-M7459-01	31.0	1.40	0.13			0.000	0.864	0.990	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	5.0	0.126	74	2.3	0.002
119	FD-W0HNT-01	10.4	1.39	0.13			0.000	0.864	0.990	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.7	0.126	74	0.8	0.002
120	-VRC20-HA	833.0	1.39	0.13			0.000	0.864	0.990	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	133.3	0.126	73	60.8	0.002
121	70-20681-01	90.1	1.38	0.13			0.000	0.865	0.990	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	14.4	0.125	73	8.6	0.002
122	FD-91721-DL	100.0	1.38	0.13			0.000	0.866	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	16.0	0.125	73	7.3	0.002
123	54-24012-01	237.0	1.38	0.13			0.000	0.866	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	37.9	0.125	73	17.3	0.002
124	30-44798-01	180.0	1.37	0.13			0.000	0.866	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	28.8	0.124	73	13.1	0.002
125	FD-85271-DL	350.0	1.37	0.13			0.000	0.866	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	56.0	0.124	73	25.6	0.002
126	FD-W07WR-01	47.9	1.37	0.13			0.000	0.866	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	7.7	0.124	73	3.5	0.002
127	-PCXAV-YB	566.5	1.37	0.13			0.000	0.866	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	90.6	0.124	72	40.8	0.002
128	-DEWGB-MA	267.5	1.37	0.13			0.000	0.866	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	42.8	0.124	72	19.3	0.002
129	FD-W06F1-01	9.7	1.35	0.12			0.000	0.868	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.6	0.122	71	0.7	0.002
130	-TLZ07-VA	607.3	1.34	0.12			0.000	0.869	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	97.2	0.122	71	43.1	0.002
131	12-19245-01	6.9	1.34	0.12			0.000	0.869	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.1	0.122	71	0.5	0.002
132	30-42693-01	199.1	1.34	0.12			0.000	0.869	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	31.9	0.121	71	14.1	0.002
133	FD-52781-01	81.4	1.34	0.12			0.000	0.869	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	13.0	0.121	71	5.8	0.002
134	FD-W0H8T-01	32.6	1.33	0.12			0.000	0.870	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	5.2	0.121	71	2.3	0.002
135	FD-90628-DL	250.0	1.32	0.12			0.000	0.871	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	40.0	0.120	70	17.5	0.002
136	29-31476-01	18.2	1.31	0.12			0.000	0.871	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.9	0.119	70	1.3	0.002
137	-DSRVF-B4	950.0	1.30	0.12			0.000	0.873	0.992	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	152.0	0.118	69	65.6	0.002
138	-TLZ07-CA	9.8	1.29	0.12			0.000	0.873	0.992	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.6	0.117	69	0.7	0.002
139	29-29005-01	14.8	1.28	0.12			0.000	0.874	0.992	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.4	0.116	68	1.0	0.002
140	17-03706-01	9.0	1.27	0.12			0.000	0.875	0.992	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.4	0.115	68	0.6	0.002
141	-TU58 -K	13.5	1.27	0.12			0.000	0.875	0.992	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.2	0.115	68	0.9	0.002
142	FD-W06KR-01	9.7	1.26	0.12			0.000	0.876	0.992	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.6	0.114	67	0.7	0.002
143	30-45256-01	30.1	1.25	0.11			0.000	0.877	0.992	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	4.8	0.114	67	2.0	0.002
144	FD-W048A-01	14.3	1.24	0.11			0.000	0.878	0.992	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.3	0.112	66	0.9	0.002
145	29-32088-01	18.2	1.23	0.11			0.000	0.879	0.992	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.9	0.111	66	1.2	0.002
146	-VRC21-KA	961.6	1.22	0.11			0.000	0.880	0.992	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	153.9	0.111	65	62.5	0.002
147	-PCXCV-TW	254.0	1.22	0.11			0.000	0.880	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	40.6	0.110	65	16.5	0.002
148	29-27388-01	223.1	1.21	0.11			0.000	0.881	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	35.7	0.110	65	14.5	0.002
149	30-44170-01	42.3	1.21	0.11			0.000	0.881	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	6.8	0.110	65	2.7	0.002
150	29-28294-01	38.3	1.21	0.11			0.000	0.881	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	6.1	0.110	65	2.5	0.002
151	-TLZ07-DX	672.0	1.20	0.11			0.000	0.881	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	107.5	0.109	65	43.7	0.002
152	-TZ87 -BX	2315.0	1.20	0.11			0.000	0.882	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	370.4	0.109	65	150.5	0.002
153	-PCXBV-KA	485.0	1.20	0.11			0.000	0.882	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	77.6	0.109	65	31.5	0.002
154	30-44935-01	35.0	1.18	0.11			0.000	0.883	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	5.6	0.107	64	2.2	0.001
155	FD-99794-DL	210.0	1.18	0.11			0.000	0.884	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	33.6	0.107	64	13.4	0.001
156	-RZ58 -E	530.0	1.18	0.11			0.000	0.884	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	84.8	0.107	64	33.9	0.001
157	-PCXAL-GS	16.5	1.17	0.11			0.000	0.885	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.6	0.106	63	1.0	0.001
158	-PCXRA-AI	165.6	1.15	0.11			0.000	0.886	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	26.5	0.105	62	10.3	0.001
159	54-24588-02	136.3	1.15	0.10			0.000	0.887	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	21.8	0.104	62	8.4	0.001
160	-PCXCV-GE	183.0	1.14	0.10			0.000	0.887	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	29.3	0.104	62	11.3	0.001
161	-TLZ06-VA	600.0	1.13	0.10			0.000	0.888	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	96.0	0.103	61	36.6	0.001
162	FD-49777-01	67.8	1.13	0.10			0.000	0.889	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	10.8	0.102	61	4.1	0.001
163	70-26534-06	49.1	1.12	0.10			0.000	0.889	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	7.9	0.102	61	3.0	0.001
164	30-42091-01	85.6	1.11	0.10			0.000	0.890	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	13.7	0.101	60	5.1	0.001
165	29-28161-01	34.6	1.10	0.10			0.000	0.891	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	5.5	0.100	60	2.1	0.001
166	30-45269-02	40.0	1.09	0.10			0.000	0.892	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	6.4	0.099	60	2.4	0.001
167	-PCXLA-GT	12.2	1.09	0.10			0.000	0.892	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.9	0.099	59	0.7	0.001
168	-PCXAL-GG	16.5	1.09	0.10			0.000	0.892	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.6	0.099	59	1.0	0.001
169	-LK411-AT	18.0	1.08	0.10			0.000	0.892	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.9	0.099	59	1.1	0.001
170	54-24631-01	1032.8	1.08	0.10			0.000	0.893	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	165.2	0.098	59	60.9	0.001
171	30-44813-01	209.8	1.08	0.10			0.000	0.893	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	33.6	0.098	59	12.4	0.001
172	54-21225-EA	19.5	1.07	0.10			0.000	0.893	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	3.1	0.098	59	1.1	0.001
173	FD-W067F-01	92.4	1.07	0.10			0.000	0.894	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	14.8	0.097	58	5.4	0.001
174	29-32549-01	15.6	1.06	0.10			0.000	0.894	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.5	0.097	58	0.9	0.001
175	FD-41595-01	100.5	1.06	0.10			0.000	0.895	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	16.1	0.096	58	5.8	0.001
176																													
177				37.6																		Total		30160	5743.0	36.8	20257	3405.3	0.541

Scenario 50-0-50; worksheet 'Groups'

	A	B	C	D	E	F	G	H	I	J
1	Groups			SSP	Country		Minimum fill-	Minimum fill-	Repl. time time Nijm-SSPs (weeks)	Stocklevel
2	Groupnumber	# partnumbers	Av. price ($)	Av. dem.	Av. dem.	pic(%)	rate SSPs	rate Nijmegen	0.1	Que in (0-..)
3	3	57	240	0.941	4.710	4.48	[illegible]	[illegible]		
4	4	86	231	0.710	3.549	5.62	[illegible]	[illegible]	The table depicts the fill-rate with	
5	5	194	271	0.502	2.508	8.80	[illegible]	[illegible]	respect to a particular group of	
6	6	470	322	0.281	1.464	12.50	[illegible]	[illegible]	spare parts, in case of different	
7	7	777	310	0.144	0.721	16.25	[illegible]	[illegible]	stock levels, stocked at three	
8	8	3513	312	0.046	0.225	14.88	[illegible]	[illegible]	possible locations.	
9	9	8407	407	0.010	0.052	5.16	[illegible]	[illegible]		
10	10	2719	407	0.003	0.014	0.71	[illegible]	[illegible]		
11	11	15662	480	0.000	0.000	0.00	[illegible]	[illegible]	Number of SSPs:	[illegible]
12										
13						62.42			Number of countries:	[illegible]
14										
15									Minimum AMC per country	
16									per spare part for stocking parts	
17									in every SSP:	[illegible]
18										
19									Minimum AMC per country	
20									per spare part for stocking parts	
21									centrally in countries:	[illegible]
22										
23									Replenishment time from vendors	
24									to Nijmegen (months):	[illegible]
25										
26									Av. lead time SSP to 'customer':	[illegible]
27									(days)	
28									Av. lead time (central) country	
29									stocking part to 'customer':	[illegible]
30									(days)	
31									Av. lead time Nijm. to 'customer':	[illegible]
32									(days)	
33										
34									Totals:	
35									Total number of parts:	127143
36										127143
37										
38									Total investment (k$):	40129.1
39										40129.1
40										
41									Contribution to LOS:	58.28
42										
43									Av. lead time in days noticed	
44									by customers:	1.80

	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
3	0.000	0.808	0.986	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
4	0.000	0.828	0.987	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
5	0.000	0.849	0.989	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
6	0.000	0.000	0.000	0.001	0.003	0.010	0.026	0.060	0.107	0.181	0.276	0.387	0.504	0.616	0.720	0.804
7	0.000	0.003	0.021	0.073	0.172	0.317	0.484	0.644	0.776	0.870	0.931	0.966	0.986	0.993	0.997	0.999
8	0.000	0.166	0.463	0.731	0.881	0.964	0.990	0.997	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000
9	0.000	0.880	0.934	0.991	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
10	0.000	0.994	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
11	0.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	AA	AB	AC	AD	AE	AF	AG	AH	AI
1	Recommended	Stocking	Total number of	Investment in	LOS	Replenishment	Total repl.	Investm. in k$	Weighted av. lead time noticed
2	stock level	location	parts on stock	stock (k$)		stock Nijm. (#)	stock Nijm. (#)	in Nijmegen	by a customer (one total)
3	2	every SSP	5320	1896.8	4.48	52	2704	649.0	0.037
4	2	every SSP	12600	3141.6	5.51	41	3486	805.0	0.046
5	2	every SSP	31040	8411.8	8.89	31	6014	1629.8	0.072
6	16	Nijmegen	7060	2270.1	10.06	no repl. stock	0	0.0	0.501
7	10	Nijmegen	7770	2408.7	9.54	no repl. stock	0	0.0	0.411
8	5	Nijmegen	18066	5636.3	14.34	no repl. stock	0	0.0	0.396
9	2	Nijmegen	10814	4401.3	4.84	no repl. stock	0	0.0	0.207
10	1	Nijmegen	2719	1108.6	0.63	no repl. stock	0	0.0	0.028
11	1	Nijmegen	15662	7572.1	0.00	no repl. stock	0	0.0	0.000
12									
13		Total	114640	37046.3	58.28		12203	3083.8	1.80

Appendix 19

Scenario 100-0-0: worksheet 'fast movers per SSP'

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC
1	Fast movers				Replenishment time	Stocklevel	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Recommended	Tot number of	Investm. in k$	LOS	Replenishment	Investm. in k$	Weighted av. lead time noticed
2	Partnumber	Price($)	Av. dem.	plc(%)	0.1	Due in (0-)		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	stock level	parts in SSPs	in SSPs		stock Nijm. (#)	in Nijmegen	by a customer (see total)
3	-LK401-AA	35.0	11.27	1.03			0.000	0.306	0.669	0.883	0.968	0.993	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	8.4	0.911	501	17.5	0.020
4	-RX23L-AA	17.1	10.15	0.93	The table depicts the fill rate with		0.000	0.344	0.712	0.907	0.977	0.995	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	4.1	0.843	453	7.7	0.017
5	29-28288-02	123.3	9.45	0.86	respect to a particular spare		0.000	0.371	0.738	0.921	0.981	0.996	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	29.6	0.797	424	52.3	0.015
6	30-43478-02	93.5	8.83	0.81	part, in case of different stock		0.000	0.396	0.763	0.933	0.985	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	22.4	0.753	397	37.1	0.014
7	54-24488-01	243.6	7.25	0.66	levels		0.000	0.467	0.822	0.958	0.992	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	58.5	0.636	330	80.4	0.010
8	-LK401-AT	26.0	6.97	0.64			0.000	0.481	0.833	0.962	0.993	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3	240	6.2	0.613	318	8.3	0.010
9	-T10XD-01	69.0	6.14	0.56	Min. fill-rate SSPs	0.84	0.000	0.525	0.863	0.972	0.996	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	11.0	0.485	283	19.5	0.012
10	-PCXAS-AD	6.4	6.06	0.55			0.000	0.529	0.866	0.973	0.996	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.0	0.480	279	1.8	0.011
11	70-26536-02	128.2	6.06	0.55	Number of SSPs	80	0.000	0.529	0.866	0.973	0.996	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	20.5	0.480	279	35.8	0.011
12	-VSXXX-GA	13.9	5.91	0.54			0.000	0.537	0.871	0.975	0.996	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.2	0.471	273	3.8	0.011
13	30-42709-01	22.5	5.65	0.52	Replenishment time vendors		0.000	0.552	0.880	0.978	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	3.6	0.455	262	5.9	0.010
14	FD-W001F-01	5.8	5.65	0.52	to Nijm. (months)	0.50	0.000	0.552	0.880	0.978	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	0.9	0.455	262	1.5	0.010
15	70-24577-02	108.2	5.54	0.51			0.000	0.559	0.884	0.979	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	17.3	0.448	257	27.8	0.010
16	-PC7XS-AA	5.4	5.54	0.51	Min. fill-rate Nijm.	0.99	0.000	0.559	0.884	0.979	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	0.9	0.448	257	1.4	0.010
17	-LK401-AP	30.0	4.89	0.45			0.000	0.598	0.906	0.985	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	4.8	0.405	229	6.9	0.008
18	PCXBV-PE	213.6	4.72	0.43	Av. lead time SSP		0.000	0.609	0.911	0.986	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	34.2	0.393	221	47.2	0.008
19	54-24068-01	235.6	4.68	0.43	to 'customer' (days)	0.5	0.000	0.612	0.912	0.986	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	37.7	0.391	220	51.8	0.008
20	-RZ28M-VA	499.1	4.47	0.41			0.000	0.625	0.919	0.988	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	79.9	0.378	211	105.3	0.007
21	-DE205-AC	39.8	4.16	0.38	Av. lead time Nijmegen		0.000	0.646	0.928	0.990	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	6.4	0.353	197	7.8	0.007
22	-PCXCV-SA	199.5	4.10	0.38	to 'customer' (days)	2.5	0.000	0.650	0.930	0.990	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	31.9	0.349	194	38.7	0.006
23	-RZ29B-VA	786.5	4.03	0.37			0.000	0.655	0.932	0.991	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	125.8	0.343	191	150.2	0.006
24	-RZ28-VA	488.2	3.93	0.36			0.000	0.662	0.935	0.991	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	78.1	0.336	187	91.3	0.006
25	-PCXBV-TD	298.0	3.67	0.34	Totals		0.000	0.680	0.942	0.993	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	47.7	0.316	175	52.2	0.005
26	29-28415-01	8.0	3.66	0.33	Parts in SSPs	21440	0.000	0.681	0.943	0.993	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.3	0.315	175	1.4	0.005
27	-RE45B-E	136.0	3.60	0.33	Parts in Nijmegen	20257	0.000	0.685	0.944	0.993	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	21.8	0.311	172	23.4	0.006
28	-PCXBV-SA	234.0	3.59	0.33		41697	0.000	0.686	0.945	0.993	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	37.4	0.310	172	40.2	0.005
29	29-25102-	9.0	3.54	0.32			0.000	0.690	0.946	0.994	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.4	0.306	170	1.5	0.005
30	70-32162-01	38.7	3.29	0.30	k$ in SSPs	3821.5	0.000	0.708	0.952	0.995	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	6.2	0.287	159	6.2	0.005
31	29-25104-	13.7	3.28	0.30	k$ in Nijmegen	3405.3	0.000	0.708	0.953	0.995	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.2	0.286	158	2.2	0.005
32	-RZ26L-E	305.0	3.25	0.30		7226.8	0.000	0.711	0.953	0.995	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	48.8	0.284	157	47.9	0.005
33	29-28287-01	12.4	3.20	0.29			0.000	0.714	0.955	0.995	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.0	0.280	155	1.9	0.005
34	-PCXRA-AF	141.0	3.11	0.28	Contribution to LOS	34.6	0.000	0.721	0.957	0.995	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	22.6	0.272	151	21.3	0.004
35	30-39608-03	331.0	3.06	0.28			0.000	0.726	0.958	0.996	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	53.0	0.268	148	49.0	0.004
36	-LK401-AG	26.0	3.01	0.28	Av. lead time in days noticed		0.000	0.729	0.959	0.996	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	4.2	0.264	147	3.8	0.004
37	29-29971-01	99.4	2.98	0.27	by customers	0.659	0.000	0.732	0.960	0.996	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	15.9	0.262	145	14.4	0.004
38	54-23170-AA	81.6	2.93	0.27			0.000	0.735	0.961	0.996	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	13.1	0.257	143	11.7	0.004
39	-PCXRA-AI	138.0	2.84	0.26			0.000	0.742	0.963	0.996	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	22.1	0.250	139	19.2	0.004
40	-PCXLA-GS	12.2	2.83	0.26			0.000	0.743	0.964	0.996	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.9	0.250	139	1.7	0.004
41	30-44823-02	300.0	2.83	0.26			0.000	0.743	0.964	0.996	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	48.0	0.249	138	41.4	0.004
42	-DEC3M-AA	35.6	2.83	0.26			0.000	0.743	0.964	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	5.7	0.249	138	4.9	0.004
43	29-32545-01	25.9	2.82	0.26			0.000	0.744	0.964	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	4.1	0.248	138	3.6	0.004
44	-BC13L-10	14.0	2.76	0.25			0.000	0.749	0.965	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.2	0.244	135	1.9	0.004
45	29-28281-01	12.2	2.73	0.25			0.000	0.751	0.966	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.0	0.242	134	1.6	0.004
46	-DE450-CA	33.6	2.67	0.24			0.000	0.756	0.967	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	5.4	0.236	131	4.4	0.004
47	-TZ30-AX	400.0	2.66	0.24			0.000	0.757	0.968	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	64.0	0.235	131	52.4	0.004
48	12-23599-08	9.1	2.64	0.24			0.000	0.758	0.968	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.5	0.234	130	1.2	0.004
49	-LK411-AA	30.5	2.59	0.24			0.000	0.762	0.969	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	4.9	0.230	128	3.9	0.004
50	-TK85K-01	28.0	2.56	0.23			0.000	0.764	0.970	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	4.5	0.227	126	3.5	0.003
51	-PCXLA-GE	12.2	2.55	0.23			0.000	0.765	0.970	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.9	0.226	126	1.5	0.003
52	-H4006-	40.3	2.45	0.22			0.000	0.773	0.972	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	6.4	0.218	122	4.9	0.003
53	29-29972-01	146.4	2.44	0.22			0.000	0.774	0.972	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	23.4	0.217	121	17.7	0.003
54	FD-44365-01	11.4	2.43	0.22			0.000	0.775	0.973	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.8	0.216	121	1.4	0.003
55	54-23580-02	104.0	2.43	0.22			0.000	0.775	0.973	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	16.6	0.216	121	12.6	0.003
56	-VRC21-HA	1066.1	2.42	0.22			0.000	0.776	0.973	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	173.8	0.215	120	130.3	0.003
57	54-22703-07	96.9	2.38	0.22			0.000	0.779	0.974	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	15.5	0.212	118	11.4	0.003
58	54-24544-02	136.8	2.35	0.22			0.000	0.781	0.974	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	21.9	0.210	117	16.0	0.003
59	-ME524-DE	28.8	2.29	0.21			0.000	0.786	0.975	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	4.6	0.204	114	3.3	0.003
60	-PCXBV-SC	293.0	2.29	0.21			0.000	0.786	0.975	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	46.9	0.204	114	33.4	0.003
61	FR-PCP7H-AD	18.0	2.28	0.21			0.000	0.787	0.976	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.9	0.203	114	2.1	0.003
62	29-28277-01	8.9	2.27	0.21			0.000	0.788	0.976	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	1.4	0.203	113	1.0	0.003
63	-TLZ07-BA	535.0	2.25	0.21			0.000	0.790	0.976	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	85.6	0.201	112	59.9	0.003
64	-PCXAL-GE	16.5	2.18	0.20			0.000	0.795	0.977	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	2.6	0.195	109	1.8	0.003
65	30-41996-01	249.0	2.18	0.20			0.000	0.796	0.978	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	39.8	0.195	109	27.1	0.003
66	29-25918-	86.8	2.17	0.20			0.000	0.796	0.978	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	13.9	0.194	109	9.5	0.003
67	-DSRVB-AB	145.0	2.15	0.20			0.000	0.798	0.978	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	23.2	0.193	108	15.7	0.003
68	FD-74510-DL	51.0	2.10	0.19			0.000	0.802	0.979	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	8.2	0.188	106	5.4	0.003
69	-LA75S-A3	214.5	2.10	0.19			0.000	0.802	0.979	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	34.3	0.188	106	22.7	0.003
70	-LN11X-AA	72.7	2.09	0.19			0.000	0.803	0.979	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	11.6	0.188	106	7.7	0.003
71	54-23544-04	162.5	2.09	0.19			0.000	0.803	0.979	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	26.0	0.187	105	17.1	0.003
72	-TK50-AX	173.9	2.08	0.19			0.000	0.804	0.979	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	27.8	0.186	105	18.3	0.003
73	FR-PCP8H-AD	31.0	2.08	0.19			0.000	0.804	0.979	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	5.0	0.186	105	3.3	0.003
74	29-29328-01	211.1	2.04	0.19			0.000	0.807	0.980	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	33.8	0.183	103	21.7	0.003
75	-PCXCV-AC	225.0	2.04	0.19			0.000	0.808	0.980	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	36.0	0.183	103	23.2	0.003
76	29-27880-01	110.8	2.01	0.18			0.000	0.810	0.981	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	17.7	0.180	102	11.3	0.003
77	-PCXBV-DE	86.4	2.01	0.18			0.000	0.810	0.981	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	13.8	0.180	102	8.8	0.003
78	70-20689-01	70.0	1.99	0.18			0.000	0.811	0.981	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	11.2	0.179	101	7.1	0.003
79	-RZ29B-VW	810.4	1.88	0.17			0.000	0.821	0.983	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	129.7	0.169	96	77.8	0.002
80	-RE24M-E	132.1	1.87	0.17			0.000	0.822	0.983	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	21.1	0.168	95	12.6	0.002
	30-41069-01	75.3	1.87	0.17			0.000	0.822	0.983	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	12.1	0.168	95	7.2	0.002
	FE-MID11-QR	79.4	1.79	0.16			0.000	0.828	0.984	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	12.7	0.162	92	7.3	0.002
	29-25916-	56.6	1.78	0.16			0.000	0.830	0.985	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	9.0	0.160	91	5.1	0.002
	70-26534-04	49.1	1.75	0.16			0.000	0.832	0.985	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	7.9	0.158	90	4.4	0.002
85	-TLZ04-DA	750.0	1.75	0.16			0.000	0.833	0.985	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	120.0	0.157	90	67.5	0.002
86	30-41318-02	25.9	1.74	0.16			0.000	0.833	0.985	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	4.1	0.157	90	2.3	0.002
87	-LK401-AS	26.0	1.72	0.16			0.000	0.835	0.985	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	4.2	0.155	89	2.3	0.002
88	70-19665-01	50.0	1.72	0.16			0.000	0.835	0.986	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	8.0	0.155	89	4.5	0.002
89	-RZ26L-VA	300.0	1.72	0.16			0.000	0.835	0.986	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	48.0	0.155	88	26.4	0.002
90	-PCXBV-TZ	286.0	1.69	0.15			0.000	0.837	0.986	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	45.8	0.152	87	24.9	0.002
91	-RD53-A	281.0	1.68	0.15			0.000	0.838	0.986	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2	160	45.0	0.152	87	24.5	0.002

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC
1	Fast movers				Replenishment time	Stocklevel	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Recommended	Tot number of	Investm in k$	LOS	Replenishment	Investm in k$	Weighted av lead time noticed
2	Partnumber	Price($)	Av dem	p(%)	0.1	Due in (0-)		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	stock level	parts in SSPs	in SSPs		stock Nijm (#)	in Nijmegen	by a customer (see total)
92	70-28824-01	6.9	1.66	0.15			0.000	0.840	0.987	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	0.5	0.127	86	0.6	0.003
93	-RX10-AA	31.4	1.65	0.15			0.000	0.841	0.987	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	2.5	0.127	85	2.7	0.003
94	-LK411-AG	18.0	1.64	0.15			0.000	0.842	0.987	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	1.4	0.126	85	1.5	0.003
95	FE-PAE06-QX	15.0	1.63	0.15			0.000	0.843	0.987	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	1.2	0.125	84	1.3	0.003
96	54-22249-01	694.1	1.63	0.15			0.000	0.843	0.987	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	55.5	0.125	84	58.3	0.003
97	-H8575-A	6.1	1.60	0.15			0.000	0.846	0.987	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	0.5	0.123	83	0.5	0.003
98	30-43517-01	724.5	1.59	0.15			0.000	0.846	0.987	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	58.0	0.123	83	60.1	0.003
99	FE-PAE10-QS	151.0	1.59	0.15			0.000	0.846	0.988	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	12.1	0.123	83	12.5	0.003
100	FD-09842-DL	300.0	1.58	0.14			0.000	0.847	0.988	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	24.0	0.123	82	24.6	0.003
101	12-41768-03	16.8	1.56	0.14			0.000	0.849	0.988	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	1.3	0.121	81	1.4	0.003
102	FD-W0JJW-01	155.0	1.54	0.14			0.000	0.851	0.988	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	12.4	0.120	80	12.4	0.003
103	-PC7XV-DE	231.0	1.54	0.14			0.000	0.851	0.988	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	18.5	0.120	80	18.5	0.003
104	-TLZ08-BA	550.0	1.54	0.14			0.000	0.851	0.988	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	44.0	0.120	80	44.0	0.003
105	29-30358-01	143.5	1.53	0.14			0.000	0.851	0.988	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	11.5	0.119	80	11.5	0.003
106	54-21246-BA	55.6	1.53	0.14			0.000	0.852	0.988	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	4.5	0.119	80	4.5	0.003
107	-RE23R-E	102.5	1.52	0.14			0.000	0.853	0.989	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	8.2	0.118	79	8.1	0.003
108	30-40850-01	1100.0	1.51	0.14			0.000	0.854	0.989	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	88.0	0.118	79	86.9	0.003
109	FD-W07WP-01	35.6	1.50	0.14			0.000	0.854	0.989	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	2.8	0.118	79	2.8	0.003
110	FD-W06P7-01	36.3	1.48	0.14			0.000	0.856	0.989	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	2.9	0.116	78	2.8	0.003
111	-TLZ08-DX	700.0	1.46	0.13			0.000	0.858	0.989	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	56.0	0.114	77	53.9	0.003
112	-VRC21-W3	971.0	1.44	0.13			0.000	0.860	0.990	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	77.7	0.113	76	73.8	0.003
113	29-28089-	139.7	1.44	0.13			0.000	0.860	0.990	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	11.2	0.113	76	10.6	0.003
114	29-28293-01	16.8	1.43	0.13			0.000	0.860	0.990	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	1.3	0.113	75	1.3	0.003
115	FD-82195-DL	345.0	1.42	0.13			0.000	0.861	0.990	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	27.6	0.112	75	25.9	0.003
116	12-13087-	10.0	1.41	0.13			0.000	0.862	0.990	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	0.8	0.111	74	0.7	0.003
117	29-28272-01	7.1	1.40	0.13			0.000	0.863	0.990	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	0.6	0.111	74	0.5	0.003
118	FD-M7458-01	31.0	1.40	0.13			0.000	0.864	0.990	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	2.5	0.110	74	2.3	0.003
119	FD-W0HNT-01	10.4	1.39	0.13			0.000	0.864	0.990	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	0.8	0.110	74	0.8	0.003
120	-VRC20-HA	833.0	1.39	0.13			0.000	0.864	0.990	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	66.6	0.110	73	60.8	0.003
121	70-20681-01	90.1	1.38	0.13			0.000	0.865	0.990	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	7.2	0.109	73	6.6	0.003
122	FD-91721-DL	100.0	1.38	0.13			0.000	0.866	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	8.0	0.109	73	7.3	0.003
123	54-24012-01	237.0	1.38	0.13			0.000	0.866	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	19.0	0.109	73	17.3	0.003
124	30-44798-01	180.0	1.37	0.13			0.000	0.866	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	14.4	0.109	73	13.1	0.003
125	FD-95271-DL	350.0	1.37	0.13			0.000	0.866	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	28.0	0.109	73	25.6	0.003
126	FD-W07WR-01	47.9	1.37	0.13			0.000	0.866	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	3.8	0.109	73	3.5	0.003
127	-PCXAV-YB	566.5	1.37	0.13			0.000	0.866	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	45.3	0.108	72	40.8	0.003
128	-DEWGB-MA	267.5	1.37	0.13			0.000	0.866	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	21.4	0.108	72	19.3	0.003
129	FD-W06F1-01	9.7	1.35	0.12			0.000	0.868	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	0.8	0.107	71	0.7	0.003
130	-TLZ07-VA	607.3	1.34	0.12			0.000	0.869	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	48.6	0.107	71	43.1	0.002
131	12-19245-01	6.9	1.34	0.12			0.000	0.869	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	0.5	0.107	71	0.5	0.002
132	30-42893-01	199.1	1.34	0.12			0.000	0.869	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	15.9	0.106	71	14.1	0.002
133	FD-52781-01	81.4	1.34	0.12			0.000	0.869	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	6.5	0.106	71	5.8	0.002
134	FD-W0H8T-01	32.6	1.33	0.12			0.000	0.870	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	2.6	0.106	71	2.3	0.002
135	FD-90628-DL	250.0	1.32	0.12			0.000	0.871	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	20.0	0.105	70	17.5	0.002
136	29-31476-01	18.2	1.31	0.12			0.000	0.871	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	1.5	0.104	70	1.3	0.002
137	-DSRVF-B4	950.0	1.30	0.12			0.000	0.873	0.992	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	76.0	0.104	69	65.6	0.002
138	-TLZ07-CA	9.8	1.29	0.12			0.000	0.873	0.992	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	0.8	0.103	69	0.7	0.002
139	29-29006-01	14.8	1.28	0.12			0.000	0.874	0.992	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	1.2	0.102	68	1.0	0.002
140	17-03706-01	9.0	1.27	0.12			0.000	0.875	0.992	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	0.7	0.102	68	0.6	0.002
141	-TU58-K	13.5	1.27	0.12			0.000	0.875	0.992	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	1.1	0.102	68	0.9	0.002
142	FD-W06KR-01	9.7	1.26	0.12			0.000	0.876	0.992	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	0.8	0.101	67	0.7	0.002
143	30-45256-01	30.1	1.25	0.11			0.000	0.877	0.992	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	2.4	0.100	67	2.0	0.002
144	FD-W048A-01	14.3	1.24	0.11			0.000	0.878	0.992	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	1.1	0.099	66	0.9	0.002
145	29-32088-01	18.2	1.23	0.11			0.000	0.879	0.992	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	1.5	0.099	66	1.2	0.002
146	-VRC21-KA	961.6	1.22	0.11			0.000	0.880	0.992	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	76.9	0.098	65	62.5	0.002
147	-PCXCV-TW	254.0	1.22	0.11			0.000	0.880	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	20.3	0.098	65	16.5	0.002
148	29-27388-01	223.1	1.21	0.11			0.000	0.881	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	17.8	0.097	65	14.5	0.002
149	30-44170-01	42.3	1.21	0.11			0.000	0.881	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	3.4	0.097	65	2.7	0.002
150	29-28294-01	38.3	1.21	0.11			0.000	0.881	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	3.1	0.097	65	2.5	0.002
151	-TLZ07-DX	672.0	1.20	0.11			0.000	0.881	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	53.8	0.097	65	43.7	0.002
152	-TZ87-BX	2315.0	1.20	0.11			0.000	0.882	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	185.2	0.097	65	150.5	0.002
153	-PCXBV-KA	485.0	1.20	0.11			0.000	0.882	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	38.8	0.097	65	31.5	0.002
154	30-44835-01	35.0	1.18	0.11			0.000	0.883	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	2.8	0.096	64	2.2	0.002
155	FD-99794-DL	210.0	1.18	0.11			0.000	0.884	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	16.8	0.095	64	13.4	0.002
156	-RZ58-E	530.0	1.18	0.11			0.000	0.884	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	42.4	0.095	64	33.9	0.002
157	-PCXAL-GS	16.5	1.17	0.11			0.000	0.885	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	1.3	0.094	63	1.0	0.002
158	-PCXRA-AL	165.6	1.15	0.11			0.000	0.886	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	13.2	0.094	62	10.3	0.002
159	54-24588-02	136.3	1.15	0.10			0.000	0.887	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	10.9	0.093	62	8.4	0.002
160	-PCXCV-GE	183.0	1.14	0.10			0.000	0.887	0.993	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	14.6	0.093	62	11.3	0.002
161	-TLZ06-VA	600.0	1.13	0.10			0.000	0.888	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	48.0	0.092	61	36.6	0.002
162	FD-49777-01	67.8	1.13	0.10			0.000	0.889	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	5.4	0.091	61	4.1	0.002
163	70-26534-06	49.1	1.12	0.10			0.000	0.889	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	3.9	0.091	61	3.0	0.002
164	30-42091-01	85.6	1.11	0.10			0.000	0.890	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	6.8	0.090	60	5.1	0.002
165	29-28161-01	34.6	1.10	0.10			0.000	0.891	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	2.8	0.090	60	2.1	0.002
166	30-45269-02	40.0	1.09	0.10			0.000	0.892	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	3.2	0.089	60	2.4	0.002
167	-PCXLA-GT	12.2	1.09	0.10			0.000	0.892	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	1.0	0.089	59	0.7	0.002
168	-PCXAL-GG	16.5	1.09	0.10			0.000	0.892	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	1.3	0.089	59	1.0	0.002
169	-LK411-AT	18.0	1.08	0.10			0.000	0.892	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	1.4	0.088	59	1.1	0.002
170	54-24631-01	1032.8	1.08	0.10			0.000	0.893	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	82.6	0.088	59	60.9	0.002
171	30-44813-01	209.8	1.08	0.10			0.000	0.893	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	16.8	0.088	59	12.4	0.002
172	54-21225-EA	19.5	1.07	0.10			0.000	0.893	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	1.6	0.088	59	1.1	0.002
173	FD-W067F-01	92.4	1.07	0.10			0.000	0.894	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	7.4	0.087	58	5.4	0.002
174	29-32549-01	15.6	1.06	0.10			0.000	0.894	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	1.2	0.087	58	0.9	0.002
175	FD-41595-01	100.5	1.06	0.10			0.000	0.895	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1	80	8.0	0.087	58	5.8	0.002
176																													
177				37.6																		Total		21440	3821.5	34.6	20257	3405.3	0.659

Scenario 100-0-0; worksheet 'Groups'

	A	B	C	D	E	F	G	H	I	J
1	Groups			SSP	Country		Minimum fill-rate SSPs	Minimum fill-rate Nijmegen	Repl. time time hpn-SSPs (months)	Stocklevel
2	Groupnumber	# partnumbers	Av. price ($)	Av. dem.	Av. dem.	pic(%)			[illegible]	Due in (0-..)
3	3	62	240	0.041	4.710	4.46	[illegible]	[illegible]		
4	4	66	231	0.710	3.540	5.57	[illegible]	[illegible]	The table depicts the fill-rate with	
5	5	184	271	0.502	2.506	8.90	[illegible]	[illegible]	respect to a particular group of	
6	6	470	322	0.281	1.464	12.50	[illegible]	[illegible]	spare parts, in case of different	
7	7	777	310	0.144	0.721	10.28	[illegible]	[illegible]	stock levels, stocked at three	
8	8	3813	312	0.046	0.229	14.66	[illegible]	[illegible]	possible locations.	
9	9	6407	407	0.010	0.052	5.16	[illegible]	[illegible]		
10	10	2716	407	0.003	0.014	0.71	[illegible]	[illegible]		
11	11	15662	483	0.000	0.000	0.00	[illegible]	[illegible]	Number of SSPs:	[illegible]
12										
13						62.42			Number of countries:	[illegible]
14										
15									Minimum AMC per country	
16									per spare part for stocking parts	
17									in every SSP:	[illegible]
18										
19									Minimum AMC per country	
20									per spare part for stocking parts	
21									centrally in countries:	[illegible]
22										
23									Replenishment time from vendors	
24									to Nijmegen (months):	[illegible]
25										
26									Av. lead time SSP to 'customer':	[illegible]
27									(days)	
28									Av. lead time (central) country	
29									stocking point to 'customer':	[illegible]
30									(days)	
31									Av. lead time Nijm. to 'customer':	[illegible]
32									(days)	
33										
34									Totals:	
35									Total number of parts:	1143447
36										1143447
37										
38									Total investment (k$):	420732.3
39										420732.3
40										
41									Contribution to LOS:	60.64
42										
43									Av. lead time in days noticed	
44									by customers:	0.56

	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
3	0.000	0.606	0.986	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
4	0.000	0.828	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
5	0.000	0.949	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
6	0.000	0.970	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
7	0.000	0.985	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
8	0.000	0.986	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
9	0.000	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
10	0.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
11	0.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	AA	AB	AC	AD	AE	AF	AG	AH	AI
1	Recommended	Stocking	Total number of	Investment in	LOS	Replenishment	Total repl.	Investm. in k$	Weighted av. lead time noticed
2	stock level	location	parts on stock	stock (k$)		stock Nijm. (#)	stock Nijm. (#)	in Nijmegen	by a customer (see total)
3	1	every SSP	4160	888.4	4.06	52	2704	649.0	0.049
4	1	every SSP	6800	1570.6	5.12	41	3486	805.0	0.057
5	1	every SSP	15620	4205.9	8.44	31	6014	1629.8	0.086
6	1	every SSP	37600	12107.2	12.12	20	9400	3028.8	0.112
7	1	every SSP	62160	16269.6	10.10	12	9324	2880.4	0.087
8	1	every SSP	266040	60180.6	14.81	5	18096	5638.3	0.121
9	1	every SSP	432560	176051.8	5.17	2	10814	4401.3	0.042
10	1	every SSP	217520	86630.6	0.71	1	2716	1105.6	0.006
11	1	Nijmegen	15662	7872.1	0.00	no repl. stock	0	0.0	0.000
12									
13		Total	1080822	400867.0	60.64		62526	20146.2	0.56

Appendix 20

Front-end worksheet

Input field for the worksheets: 'Fast movers per SSP' and 'Groups'

	Inventory	Fill-rate	AMC	Time
Number of SSPs:	80			
Number of countries:	16			
Minimum required fill-rate at the SSPs (0<Fill-rate<1):		0.95		
Minimum required fill-rate at Nijmegen (0<Fill-rate<1):		0.90		
Minimum AMC per <u>country</u> per spare part for stocking parts in every SSP:			1	
Minimum AMC per <u>country</u> per spare part for stocking parts centrally in countries:			0.2	
Average lead time in **days** from the SSPs to 'customers':				0.5
Average lead time in **days** from (central) country stocking points to 'customers':				1
Average lead time in **days** from Nijmegen to 'customers':				2.5
Average replenishment time in **months** from Nijmegen to the SSPs:				0.1
Average replenishment time in **months** from the vendors to Nijmegen:				0.5

Results (see worksheets for detailed information)

	Invest. k$	LOS (%)	% demand	Time (days)
Same Business Day (SBD)				
Investment in **SSPs**:	31751.6			
LOS for parts delivered <u>to customers</u> by **SSPs**:		97.9	69.0	
Av. lead time parts delivered <u>to customers</u> by **SSPs**:				0.54
Next Business Day (NBD) or more				
Investment in (central) **country** stock rooms:	25743.9			
LOS for parts delivered <u>to customers</u> by (central) **country** stock rooms:		97.8	25.1	
Av. lead time parts delivered <u>to customers</u> by (central) **country** stock rooms:				1.03
Investments in **Nijmegen** (replenishment stock included):	29284.1			
LOS for parts delivered <u>to customers</u> by **Nijmegen**:		94.1	5.9	
Av. lead time parts delivered <u>to customers</u> by **Nijmegen**:				2.5
Total investment:	86779.6			
Overall Level Of Service:		97.7	100.0	
Overall av. lead time <u>to customers</u>:				0.78
Compared to sample:	107339.8			